Foreword

This soil survey contains information that can be used in land-planning programs in Grays Harbor County Area, Pacific County, and Wahkiakum County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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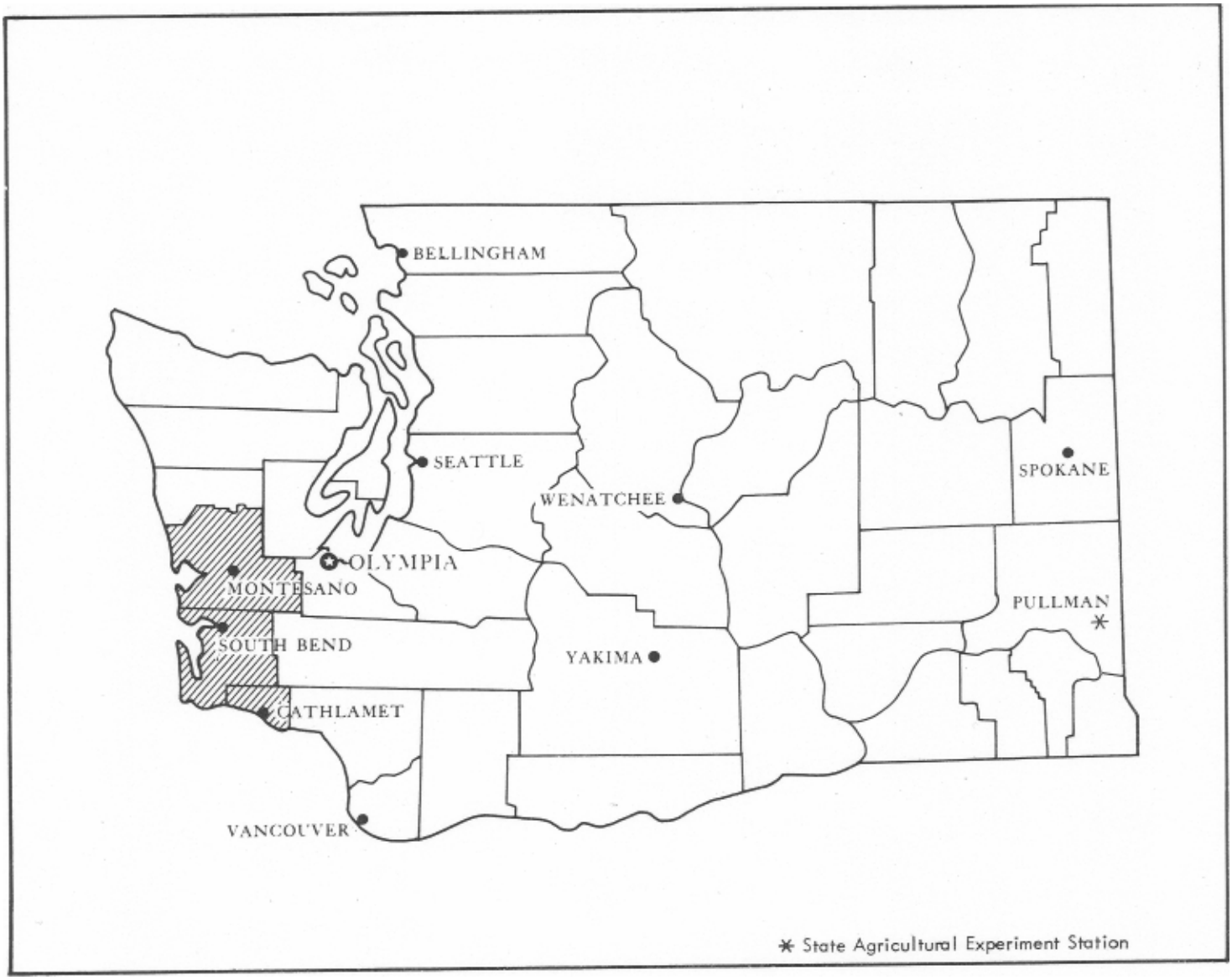

Location of Grays Harbor County Area, Pacific County, and Wahkiakum County in Washington.

Soil Survey of
Grays Harbor County Area, Pacific County, and Wahkiakum County, Washington

By Russell F. Pringle, Soil Conservation Service

Fieldwork by Russell F. Pringle, Steven B. Campbell, and Carl J. McMurphy, Soil Conservation Service, and Ralph V. Minden, John W. Jennings, and Steven M. Howes, Washington State Department of Natural Resources

Woodland Fieldwork by George Carnine, Washington State Department of Natural Resources

United States Department of Agriculture, Soil Conservation Service
In cooperation with Washington State Department of Natural Resources, and Washington State University, Agriculture Research Center

GRAYS HARBOR COUNTY AREA, PACIFIC COUNTY, AND WAHKIAKUM COUNTY comprise the southwestern coastal region of Washington. The survey area makes up about 1,625,570 acres, or about 2,540 square miles.

The Columbia River forms the southern border of the survey area. The Pacific Ocean is to the west, the Quinault Indian Reservation and the Olympic National Forest are to the north, and Cowlitz, Thurston, Lewis, and Mason Counties are to the east. Aberdeen, in Grays Harbor County, is the largest city in the survey area. It is 108 miles southwest of Seattle and about 49 miles west of Olympia.

The topography in much of the survey area is hilly and steep. The foothills of the Olympic Mountains are in the northern part of the area, and the Willapa Hills are in the central part. Elevation ranges from sea level along the Pacific Ocean to about 2,700 feet in the northeastern corner of the area. The survey area is drained by eleven river systems-the Chehalis, Columbia, Elochoman, Grays, Humptulips, Naselle, North, Satsop, Willapa, Wishkah, and Wynoochee Rivers.

The original vegetation in the area was conifers. The first sawmill was built near Grays Harbor in the early 1880's. Since then, the lumber industry has dominated the development and economy of the area. Virgin Douglas-fir, Sitka spruce, and western redcedar were logged. Lumber from the forests supplied local needs and those of the rapidly expanding market for building materials in California.

Forestry movements, such as the Washington Forest Protection Association, the Keep Washington Green Program, and the Tree Farm Movement, were either initiated or strongly supported by forest owners. In 1908, owners of public and private forests were instrumental in forming the Washington Forest Protection Association, which was formed to provide protection from fire. In 1940, the forest owners in the survey area were active in developing the Keep Washington Green Program. This was the first such program in the United States.

The first privately owned certified tree farm in the United States, the Clemons Tree Farm, was established near Montesano in Grays Harbor County in 1941. Currently, there are 49 certified tree farms in the survey area.

This highly productive area continues to be a major supplier of wood products to the state and nation and to the export markets of the world. The high level of production has been maintained through better use of resources and through improvements in forest management. The major land use in the survey area is forestry. About 92 percent of the land area, or 1,495,525 acres, is in woodland (3). The principal forest products

are softwood and hardwood lumber, shingles, shakes, poles, pilings, and pulpwood. Minor forest products such as tree boughs, floral greenery, and cascara bark are also harvested.

Additional principal sources of income are mariculture, recreation, and farming. Commercial fisheries within the survey area produce, in order of the most value, crab, salmon, and oysters. Albacore, smelt, and razor clams are also important resources.

Most of the farmland is planted to pasture or hay for use by livestock. Other crops are oats, wheat, Christmas trees, flower bulbs, vegetables, peas, and cranberries.

Six previous soil surveys have been completed for parts of the soil survey area: Soil Survey of Pacific County Area, Washington (unpublished) 1970; Soil Survey of Grays Harbor County Area, Washington (unpublished) 1970; Soil Survey of Capitol Forest Area, published in 1968 (15); Soil Survey of the St. Helens Tree Farm, published in 1971 (8); Soil Survey of the McDonald Tree Farm, published in 1966 (23); and Soil Survey of the Clemons Tree Farm, published in 1969 (22). The present survey updates the earlier surveys, provides a survey of areas omitted in earlier surveys, and provides additional information and maps that show the soils in greater detail.

Descriptions, names, and delineations of soils in this soil survey do not fully agree with those on soil maps of adjacent survey areas. Differences are the result of better knowledge of soils, modifications in series concepts, intensity of mapping, or the extent of soils within the survey.

Climate

By Earl Phillips, climatologist for Washington, National Weather Service, U.S. Department of Commerce, and the National Climatic Center, Asheville, North Carolina.

The climate of the survey area is influenced by the prevailing direction of the wind, the surface temperature of the Pacific Ocean, the Coast and Cascade Ranges, and the position and intensity of the large high- and low-pressure centers over the ocean. The summers are cool and comparatively dry, and the winters are mild, wet, and cloudy. The air is moist, and the annual range in temperature is narrow. The ocean current near the coast reverses directions between summer and winter; in summer the California Current moves southward, and in winter the Davidson Current moves northward. The temperature of the water along the coast ranges from 48 degrees F in February and March to 58 degrees in August.

In spring and summer, a large high-pressure area covers most of the northeastern Pacific Ocean. The prevailing flow of air into Washington is from the northwest. In midsummer, the average air temperature over the ocean ranges from 55 to 60 degrees F. As the air moves inland, it becomes warmer and drier. This flow of air results in a dry season that begins late in spring and reaches its peak in midsummer.

In fall and winter, a low-pressure center near the Aleutian Islands intensifies and spreads southward. At the same time, the high-pressure center over the northeastern Pacific Ocean becomes smaller and also moves southward. This causes the prevailing flow of warm, moist air to shift from the west to the southwest. Fog banks frequently form offshore and move inland at night, but the beaches are clear by the following noon.

In winter, weather disturbances crossing the North Pacific follow a more southerly course, and the number of storms striking the Washington coast increase. Wind velocity normally ranges from 50 to 70 miles per hour as intense storms move inland, but the velocity has been recorded at 113 miles per hour at North Head and at 100 miles per hour on peaks of the Willapa Hills. In spring, the ocean becomes calmer and the frequency of storms decreases. The high-pressure area spreads northward, and the prevailing direction of the wind gradually shifts from southwest to west.

Tables 1, 2, and 3 give data as recorded at Aberdeen, Elma, Grays River, and Willapa Harbor, Washington, for the period 1951 to 1977. The information in these tables is based on incomplete records. Table 1 gives data on temperature and precipitation for the survey area. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 41 to 42 degrees F and the average daily minimum temperature is 33 to 36 degrees. Colder periods occur, usually when cold, dry, northeasterly or easterly winds from east of the Cascade Range reach the coast. The sky is frequently clear under these conditions, and additional heat is lost by radiation at night. The lowest temperature on record, which occurred at Elma and at Grays River on December 8, 1972, is 2 degrees. The colder weather seldom continues for more than a few days before the warmer, moist air from the ocean moves inland. In summer, the average temperature is 60 to 62 degrees and the average daily maximum temperature is 71 degrees. The highest recorded temperature, which occurred at Elma on July 20, 1956, is 105 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall. In the cranberry bogs near the ocean, the first frost in fall is near the end of October.

In beach areas some distance from the hills, the annual precipitation generally ranges from 65 to 75 inches. Near the foothills, annual precipitation ranges from 80 to 90 inches. It increases to 100 inches in the

Willapa Hills and ranges from 125 to 150 inches or more in the rain forest along the windward slopes of the Olympic Mountains. The total annual precipitation is 84 inches at Aberdeen, 68 inches at Elma, 114 inches at Gray River, and 87 inches at Willapa Harbor. Of this, 20 percent usually falls in April through September. The growing season for most crops is within this period. The heaviest 1-day rainfall during the period of record was 6.1 inches at Grays River on December 2, 1977. Thunderstorms occur on about 5 or 6 days each year, and most occur in summer.

Snowfall is light in the beach areas, and the snow frequently melts as it falls. Snowfall increases in the foothills, and the higher elevations of the Olympic Mountains are covered with snow from early in winter until late in spring. The average seasonal snowfall is 9 inches at Aberdeen, 10 inches at Elma, 9 inches at Grays River, and 6 inches at Willapa Harbor. The greatest snow depth at any one time during the period of record was 19 inches at Elma. On an average of 1 or 2 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 65 to 70 percent. Humidity is higher at night, and the average at dawn is about 90 percent. In midsummer, easterly winds that are hot and dry sometimes cross the Cascade Range and reach the coast and relative humidity sometimes drops to 30 percent. The sun shines 45 percent of the time in summer and 20 percent in winter. The prevailing wind is from the south-southwest. Average windspeed is highest, 8 or 9 miles per hour, in winter.

How This Survey Was Made

This survey was made to provide information about the soils and miscellaneous areas in the survey area. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils and miscellaneous areas in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind or segment of the landscape. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Individual soils on the landscape commonly merge into one another as their characteristics gradually change. To construct an accurate map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While the soil survey was in progress, samples of some of the soils in the area were collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses and under different levels of management. Some interpretations were modified to fit local conditions, and some new interpretations were developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a

fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

General Soil Map Units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The soils or miscellaneous areas making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils or miscellaneous areas can be identified on the map. Likewise, areas that are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The general map units in this survey have been grouped into general kinds of landscape for broad interpretive purposes. Each of the broad groups and the map units in each group are described in the following pages.

Soils on flood plains, terraces, dunes, and fans

Four map units are on these landscape positions. They make up about 12 percent of the survey area.

1. Ocosta

Very deep, poorly drained, nearly level soils; on flood plains and deltas protected from tidal overflow

This map unit is along coastal bays in the survey area. Slope is 0 to 2 percent. The vegetation is mainly grasses and sedges and an overstory of hardwoods and conifers. Elevation ranges from sea level to 20 feet. The average annual precipitation is 50 to 100 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

This unit makes up about 3 percent of the survey area. It is about 80 percent Ocosta soils. The remaining 20 percent is components of minor extent (fig. 1).

The very deep, poorly drained Ocosta soils formed in alluvium deposited in coastal bays. Drainage has been

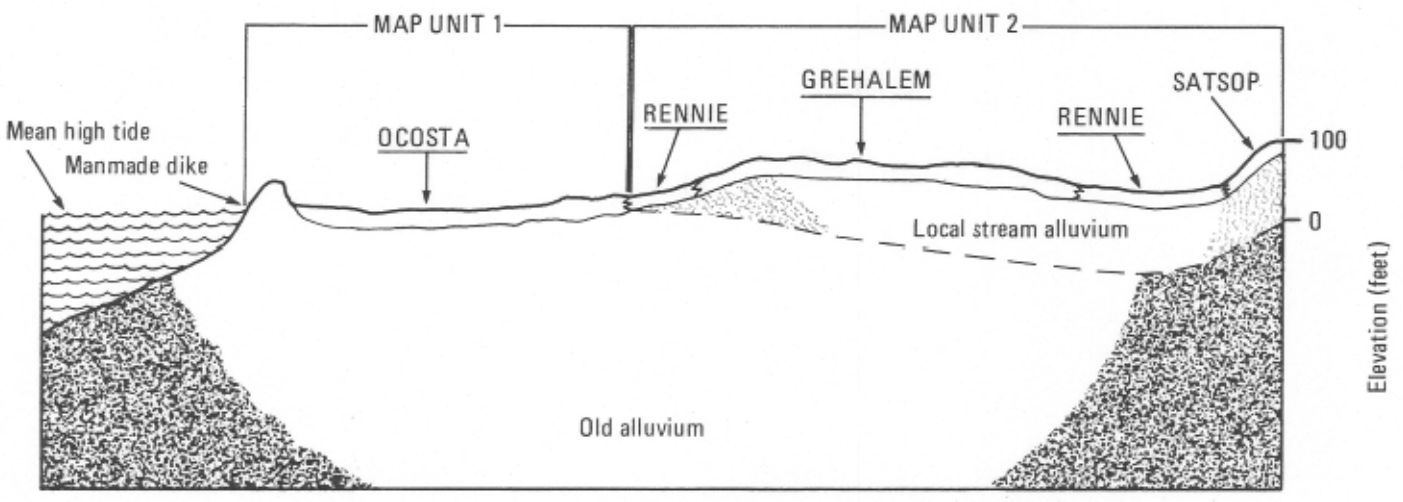

Figure 1.-Pattern of soils and parent material in general soil map units 1 and 2.

altered by ditching, tiling, and pumping. The surface is covered with a mat of sedge and grass leaves. The surface layer is silty clay loam. The underlying material to a depth of 60 inches or more is silty clay and clay.

Of minor extent in this unit are areas of Sauvie soils; Beaches; Fluvaquents, tidal; and excessively drained Udipsamments, level.

This unit is used mainly for hay, pasture, and crops and as habitat for openland and wetland wildlife. It is poorly suited to homesite development and to use as woodland. If this unit is used for homesite development or as woodland, the main limitation is the high water table.

2. Grehalem-Rennie

Very deep, well drained and poorly drained, nearly level soils, on flood plains

This map unit is along drainageways throughout the survey area. Slope is 0 to 3 percent. The vegetation is mainly grasses and sedges and an overstory of hardwoods and conifers. Elevation ranges from sea level to 100 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

This unit makes up about 4 percent of the survey area. It is about 35 percent Grehalem soils and 15 percent Rennie soils. The remaining 50 percent is components of minor extent (see fig. 1).

The well drained Grehalem soils formed in alluvium derived dominantly from basic igneous and sedimentary rock. Slope is 0 to 3 percent. The surface layer is silt loam. The underlying material to a depth of 60 inches or more is dominantly silty clay loam.

The poorly drained Rennie soils are in depress ional areas. They formed in alluvium derived dominantly from basic igneous and sedimentary rock. Slope is 0 to 2 percent. The surface layer is silty clay loam. The subsoil and substratum to a depth of 60 inches or more are silty clay and clay.

Of minor extent in this unit are areas of somewhat poorly drained Aabab soils, somewhat excessively drained Humptulips soils, poorly drained Nemah and Nuby soils, and well drained Satsop soils.

This unit is used for hay, pasture, crops, wildlife habitat, woodland, and homesites. If the unit is used for homesite development, the main limitations are the hazard of flooding and a seasonal high water table.

3. Chehalis-Skamo-Spanaway

Very deep, moderately well drained to somewhat excessively drained, nearly level to gently sloping soils; on flood plains, terraces, and fans

This map unit is in the southeastern part of Grays Harbor County. Slope is 0 to 8 percent. The vegetation is mainly grasses and sedges and an overstory of conifers and hardwoods. Elevation is 50 to 200 feet. The average annual precipitation is 50 to 90 inches, the average annual air temperature is 50 to 52 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

This unit makes up about 2 percent of the survey area. It is about 35 percent Chehalis soils, 25 percent Skamo soils, and 15 percent Spanaway soils. The remaining 25 percent is components of minor extent (fig. 2).

The well drained Chehalis soils are on flood plains. They formed in alluvium. Slope is 0 to 3 percent. The surface layer is silt loam. The subsoil to a depth of 52 inches is silt loam and silty clay loam. The substratum to a depth of 60 inches or more is silt loam.

The moderately well drained Skamo soils are on terraces and fans. They formed in alluvium derived dominantly from basic igneous and sedimentary rock. Slope is 0 to 8 percent. The surface is covered with a mat of needles, leaves, and twigs. The surface layer is silt loam. The subsoil and substratum to a depth of 60 inches or more are silty clay loam.

The somewhat excessively drained Spanaway soils are on outwash terraces. They formed in glacial outwash derived from various kinds of rock. Slope is 1 to 8 percent. The surface is covered with a mat of moss. The surface layer is very gravelly sandy loam. The subsoil is extremely gravelly sandy loam to a depth of 16 inches. The substratum to a depth of 60 inches or more is extremely gravelly sand.

Of minor extent in this unit are areas of well drained Cloquato soils; somewhat excessively drained Carstairs and Lyre soils; well drained Newberg soils; very poorly drained Salzer soils; and well drained Satsop soils.

This unit is used mainly for hay, pasture, and crops. It is also used as homesites, for woodland, and as wildlife habitat. An additional use is as a source of gravel.

This unit is well suited to hay, pasture, and crops and to habitat for open land and woodland wildlife. If the Chehalis soils are used for homesite development, the main limitation is the hazard of flooding. If the Skamo soils are used for septic tank absorption fields, the main limitation is a seasonal high water table. The Spanaway soils are well suited to homesite development.

4. Yaquina-Netarts-Dune land

Very deep, somewhat poorly drained and well drained, nearly level to moderately steep soils, on dunes

This map unit is along the Pacific Coast. Slope is 0 to 30 percent. The vegetation is mainly grasses, sedges, and conifers. Elevation is sea level to 100 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

This unit makes up about 3 percent of the survey area. It is about 20 percent Yaquina soils, 20 percent Netarts soils, and 10 percent Dune land. The remaining 50 percent is components of minor extent (fig. 3).

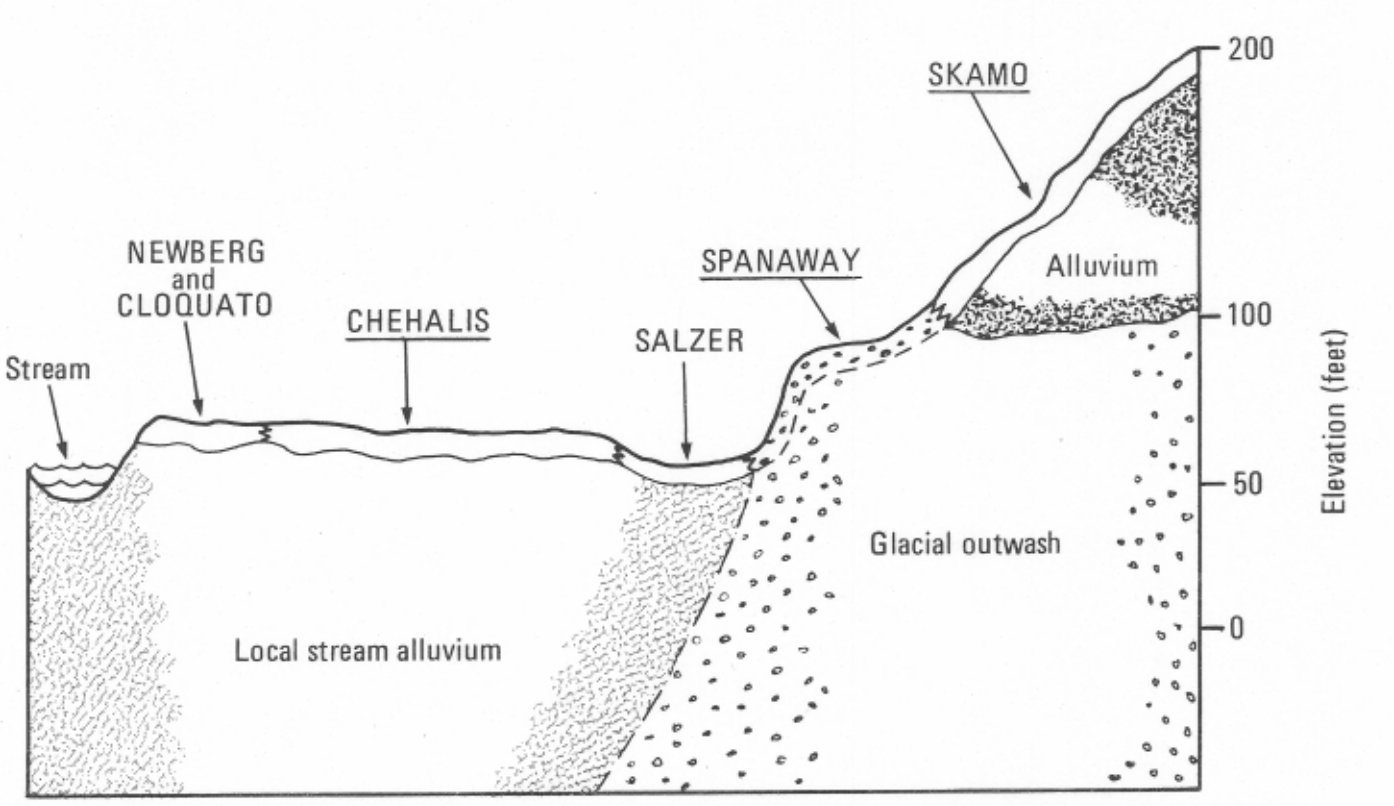

Figure 2.-Pattern of soils and parent material in general soil map unit 3.

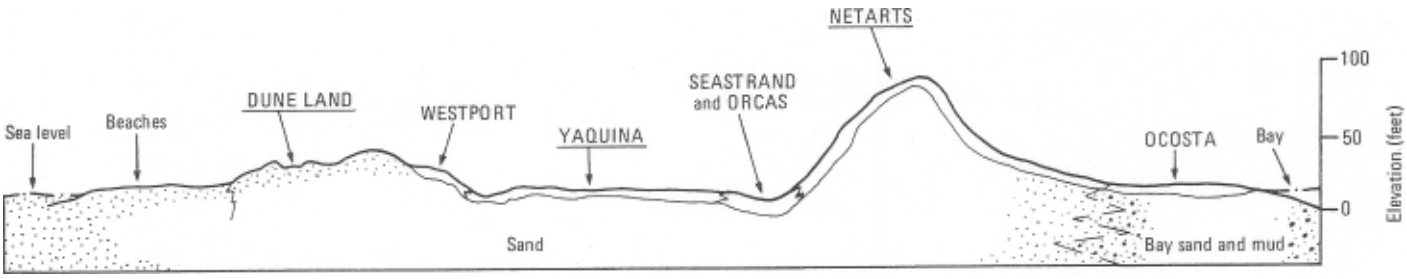

Figure 3.-Pattern of soils and parent material in general soil map unit 4.

The somewhat poorly drained Yaquina soils are in depressional areas between stabilized sand dunes. They formed in sand. Slope is 0 or 1 percent. The surface layer is loamy fine sand. The subsoil and substratum to a depth of 60 inches or more are fine sand.

The well drained Netarts soils are on stabilized sand dunes. They formed in sand. Slope is 3 to 12 percent. These soils are fine sand to a depth of 60 inches or more.

Dune land consists of ridges, dunes, and hummocks of sand piled up by the wind along the ocean shore. Slope is 0 to 30 percent.

Of minor extent in this unit are areas of poorly drained Ocosta soils, very poorly drained Orcas and Seastrand soils, and excessively drained Westport soils.

This unit is used mainly for recreation areas and homesites. It is also used as woodland and wildlife habitat. If this unit is used for septic tank absorption fields, the main limitation is a seasonal high water table in the Yaquina soils. The Netarts soils and Dune land are poor filters for septic tank absorption fields.

Soils on glacial uplands

Two map units are on these landscape positions. They make up about 19 percent of the survey area.

5. Hoquiam-Le Bar

Deep and very deep, well drained, nearly level to steep soils; on uplands

This map unit is in the northern part of the survey area. Slope is 1 to 65 percent. The vegetation is mainly conifers. Elevation is 100 to 900 feet. The average annual precipitation is 80 to 130 inches, the average annual air temperature is 48 to 50 degrees F, and the average growing season (at 28 degrees) is 180 to 240 days.

This unit makes up about 15 percent of the survey area. It is about 30 percent Hoquiam soils and 20 percent LeBar soils. The remaining 50 percent is components of minor extent (fig. 4).

The deep Hoquiam soils are on ground moraines of uplands. They formed in old alluvium deposited over glacial drift. Slope is 1 to 65 percent. The surface is covered with a mat of twigs and leaves. The surface layer is silt loam. The subsoil is gravelly silt loam and gravelly sandy loam. Dense glacial drift is at a depth of about 51 inches. Depth to the glacial drift ranges from 40 to 55 inches.

The very deep Le Bar soils are on terraces and benches of uplands. They formed in old alluvium. Slope is 1 to 65 percent. The surface is covered with a mat of twigs and leaves. The surface layer is silt loam. The subsoil is silt loam to a depth of 60 inches or more.

Of minor extent in this unit are areas of the well drained Calawah, Copalis, Mopang, and Papac soils, and the somewhat poorly drained Wishkah soils.

Most areas of this unit are used as woodland, wildlife habitat, or recreation areas. A few areas are used as rural homesites. This unit is well suited to use as woodland and recreation areas. If the unit is used for homesite development, the main limitation is steepness of slope.

6. Halbert-Willaby

Shallow and very deep, poorly drained and moderately well drained, nearly level to moderately steep soils; on uplands

This map unit is in the northern part of the survey area. Slope is 1 to 15 percent. The vegetation is mainly conifers. Elevation is 50 to 500 feet. The average annual precipitation is 80 to 150 inches, the average annual air temperature is 48 to 50 degrees F, and the average growing season (at 28 degrees) is 180 to 240 days.

This unit makes up about 4 percent of the survey area. It is about 25 percent Halbert soils and 20 percent Willaby soils. The remaining 55 percent is components of minor extent (fig. 5).

The shallow, poorly drained Halbert soils are on outwash plains on uplands. They formed in glaciolacustrine sediment deposited over glacial outwash. Slope is 0 to 10 percent. The surface is covered with a mat of needles and twigs. The surface layer is muck. The subsoil is silty clay loam. An indurated iron pan is at a depth of about 26 inches. Depth to the iron pan ranges from 20 to 40 inches.

The Willaby soils are on terraces of uplands. They are very deep and moderately well drained. These soils

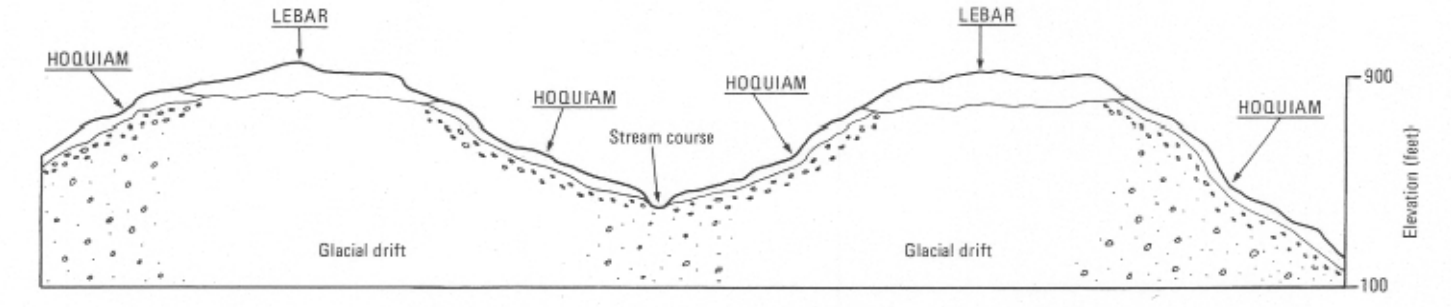

Figure 4.-Pattern of soils and parent material in general soil map unit 5.

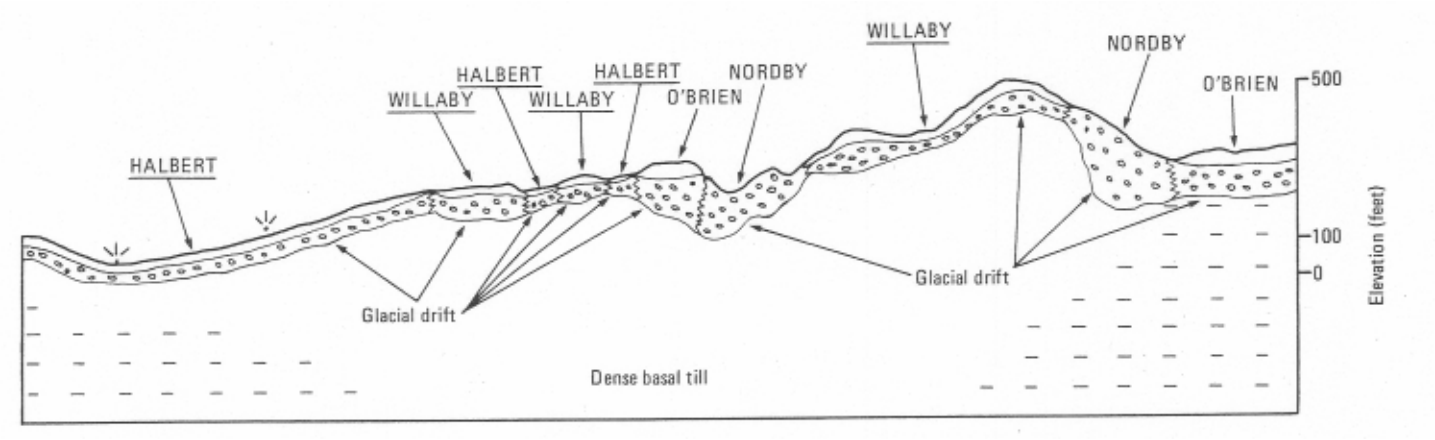

Figure 5.-Pattern of soils and parent material in general soil map unit 6.

formed in glacial drift. Slope is 1 to 15 percent. The surface is covered with a mat of leaves, needles, twigs, and moss. The surface layer is silt loam. The subsoil is silty clay in the upper part and very gravelly silty clay in the lower part. The substratum to a depth of 60 inches or more is extremely gravelly silty clay loam.

Of minor extent in this unit are areas of somewhat excessively drained Nordby soils, well drained O'Brien soils, and moderately well drained Oyhut soils.

This unit is used mainly as woodland, recreation areas, and wildlife habitat. If the unit is used as woodland, the main limitation is a seasonal high water table.

Soils on marine terraces and uplands

Four map units are on these landscape positions. They make up about 48 percent of the survey area.

7. Lytell-Astoria

Deep and very deep, well drained, nearly level to extremely steep soils; on siltstone uplands

This map unit is on broad low ridges and uneven side slopes throughout the survey area. Areas of this unit include weakly defined, irregular, dendritic streams. Slope is 3 to 90 percent. The vegetation is mainly conifers. Elevation is 20 to 1,500 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is 48 to 50 degrees F, and the average growing season (at 28 degrees) is 180 to 240 days.

This unit makes up about 17 percent of the survey area. It is about 55 percent Lytell soils and 15 percent Astoria soils. The remaining 30 percent is components of minor extent (fig. 6).

The deep Lytell soils are on slumps on uplands. They formed in colluvium derived dominantly from marine siltstone and fine-grained sandstone. Slope is 8 to 90 percent. The surface is covered with a mat of twigs and needles. The surface layer is silt loam. The subsoil is silty clay loam over siltstone, which is at a depth of about 50 inches. Depth to weathered siltstone ranges from 40 to 60 inches or more.

The very deep Astoria soils are on uplands. They formed in residuum derived dominantly from siltstone. Slope is 3 to 65 percent. The surface layer is silt loam. The subsoil to a depth of 60 inches or more is silty clay.

Of minor extent in this unit are areas of moderately well drained Arta soils, well drained Bunker, Lebam, and Palix soils, and moderately well drained Swem soils.

This unit is used mainly as woodland, wildlife habitat, and recreation areas. It is also used for hay, pasture, and rural homesites. If this unit is used for homesite development, the main limitations are steepness of slope and the hazard of sliding.

8. Zenker-Elochoman

Very deep, well drained, nearly level to extremely steep soils; on sandstone uplands

This map unit is on sharp ridges and long slopes throughout the survey area. Areas of this unit include strongly defined, dendritic streams. Slope is 1 to 90 percent. The vegetation is mainly conifers. Elevation ranges from 50 to 1,800 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is 48 to 50 degrees F, and the average growing season (at 28 degrees) is 180 to 240 days.

This unit makes up about 18 percent of the survey area. It is about 50 percent Zenker soils and 40 percent Elochoman soils. The remaining 10 percent is components of minor extent (fig. 7).

The Zenker soils are on shoulders, back slopes, and foot slopes of uplands. They formed in colluvium derived

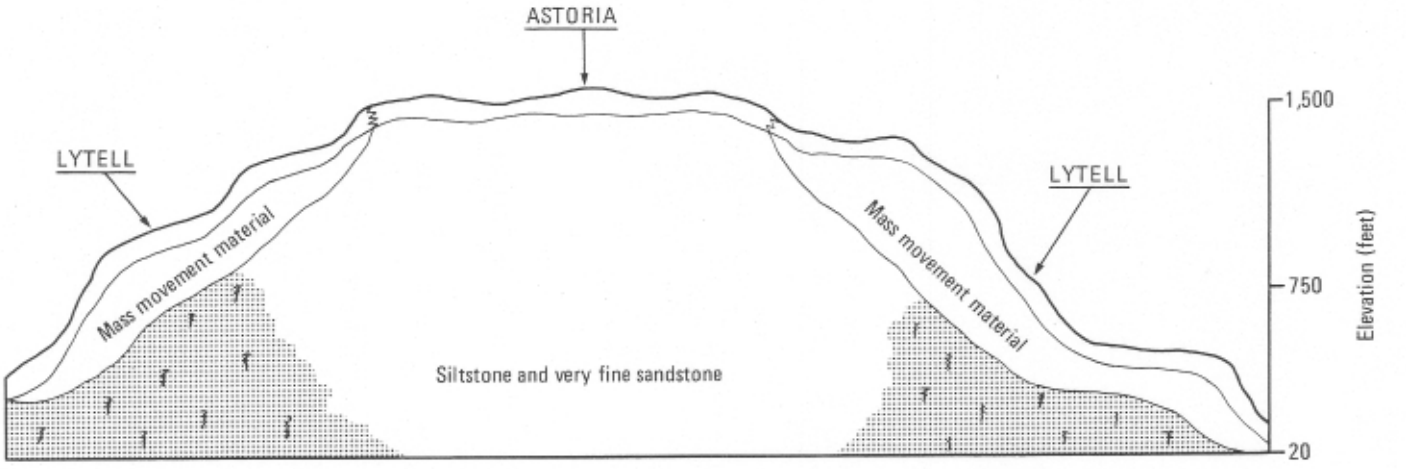

Figure 6.-Pattern of soils and parent material in general soil map unit 7.

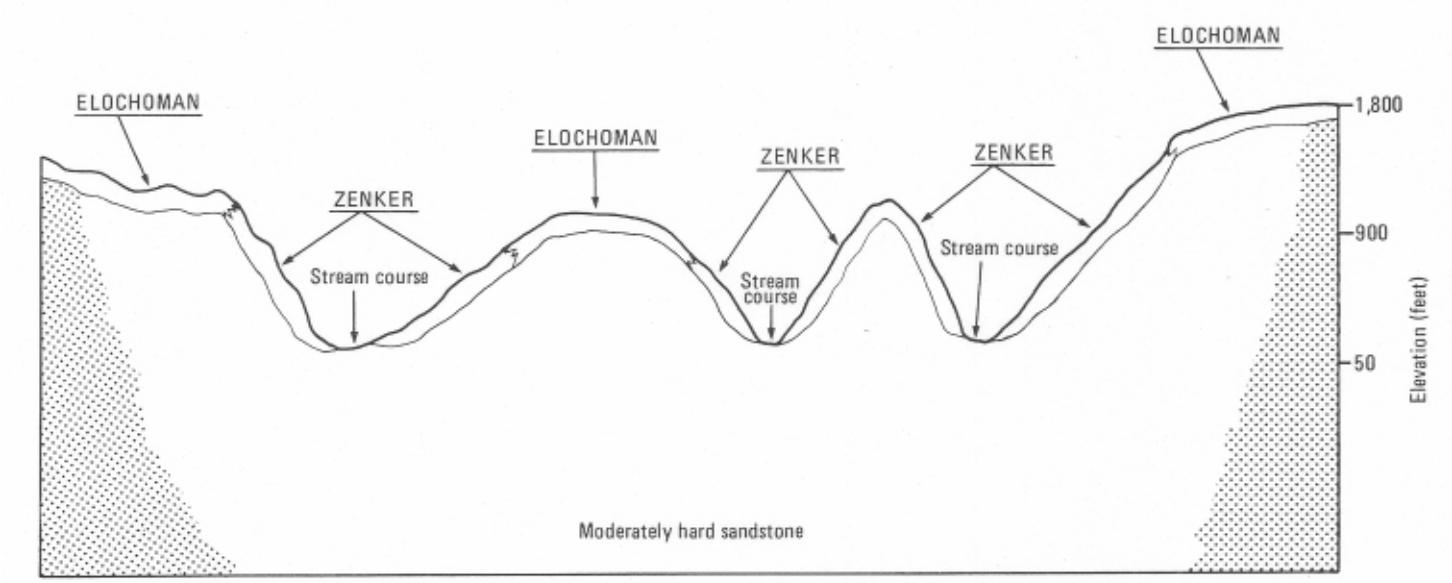

Figure 7.-Pattern of soils and parent material in general soil map unit 8.

dominantly from marine sandstone. Slope is 8 to 90 percent. The surface layer is silt loam. The subsoil is dominantly loam to a depth of 60 inches or more.

The Elochoman soils are on uplands. They formed in residuum derived dominantly from sandstone. Slope is 1 to 65 percent. The surface layer is silt loam. The subsoil is silt loam to a depth of 60 inches or more.

Of minor extent in this unit are areas of Ilwaco and Narel soils.

This unit is used mainly as woodland, wildlife habitat, and recreation areas. It is also used as rural homesites. If this unit is used for homesite development, the main limitations are steepness of slope and the hazard of sliding.

9. Buckpeak-Centralia

Deep and very deep, well drained, nearly level to

extremely steep soils; on siltstone and sandstone uplands

This map unit is on low ridges and uneven side slopes in the southeastern part of Grays Harbor County. Areas of this unit include dendritic streams. Slope is 1 to 90 percent. The vegetation is mainly conifers. Elevation ranges from 200 to 1,200 feet. The average annual precipitation is 50 to 75 inches, the average annual air temperature is 50 to 51 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

This unit makes up about 6 percent of the survey area. It is about 50 percent Buckpeak soils and 35 percent Centralia soils. The remaining 15 percent is components of minor extent (fig. 8).

The deep Buckpeak soils are on shoulders, slumps, and foot slopes on uplands. They formed in residuum and colluvium derived dominantly from siltstone. Slope is 8 to 90 percent. The surface is covered with a mat of needles and twigs. The surface layer is silt loam. The subsoil is silty clay loam. Siltstone is at a depth of about 47 inches. Depth to weathered siltstone ranges from 40 to 60 inches or more.

The very deep Centralia soils are on broad ridgetops, shoulders, and back slopes of uplands. They formed in residuum and colluvium derived dominantly from sandstone. Slope is 1 to 65 percent. The surface is covered with a mat of needles and twigs. The surface layer is loam. The subsoil is clay loam. The substratum to a depth of 60 inches or more is loam.

Of minor extent in this unit are areas of Melbourne, Olympic, and Raught soils.

This unit is used mainly as woodland and wildlife habitat. It is also used for hay, pasture, rural homesites, and recreation areas. This unit is well suited to use as woodland and recreation areas. If the unit is used for homesite development, hay, or pasture, the main limitation is steepness of slope.

10. Willapa-Newskah

Very deep, moderately well drained and well drained, nearly level to extremely steep soils; on marine terraces

This map unit is in the western part of the survey area. Slope is 1 to 90 percent. The vegetation is mainly conifers. Elevation is 20 to 500 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

This unit makes up about 7 percent of the survey area. It is about 45 percent Willapa soils and 20 percent Newskah soils. The remaining 35 percent is components of minor extent (fig. 9).

The moderately well drained Willapa soils are on wave-cut marine terraces. They formed in stratified marine sediment. Slope is 1 to 70 percent. The surface is covered with a mat of needles, leaves, and twigs. The surface layer is silt loam. The subsoil and substratum to a depth of 60 inches or more are silty clay loam.

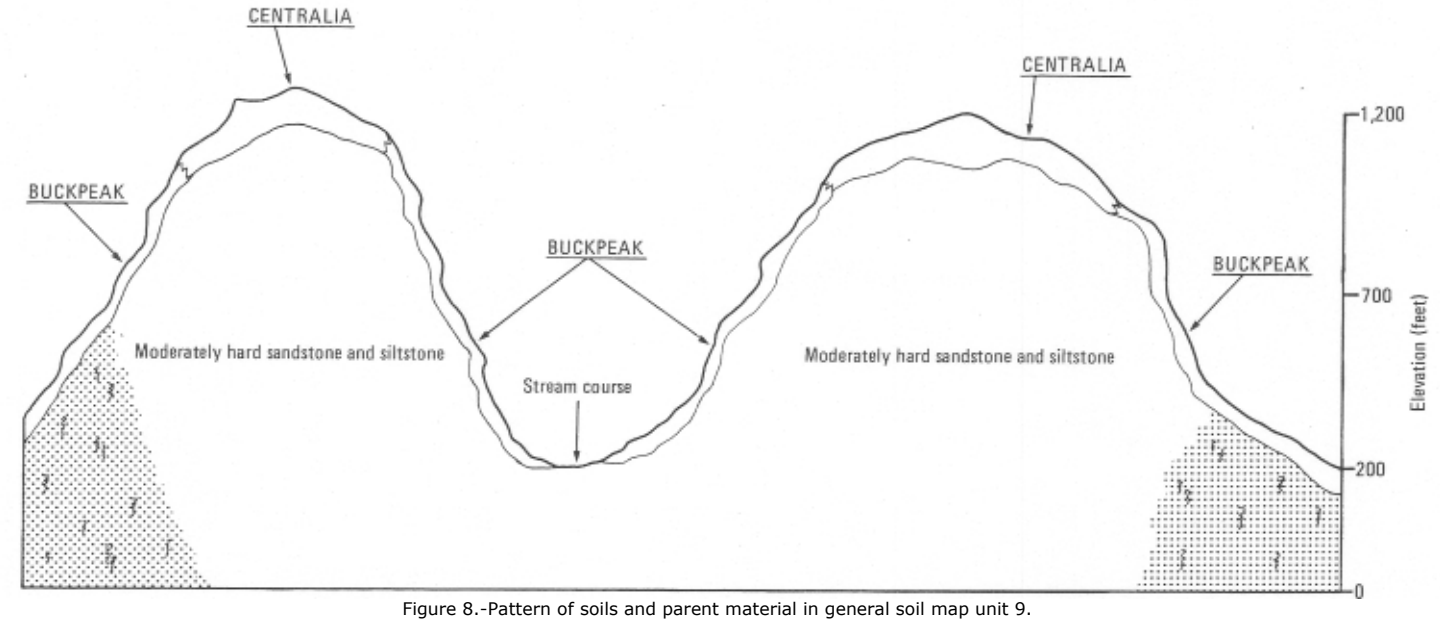

Figure 8.-Pattern of soils and parent material in general soil map unit 9.

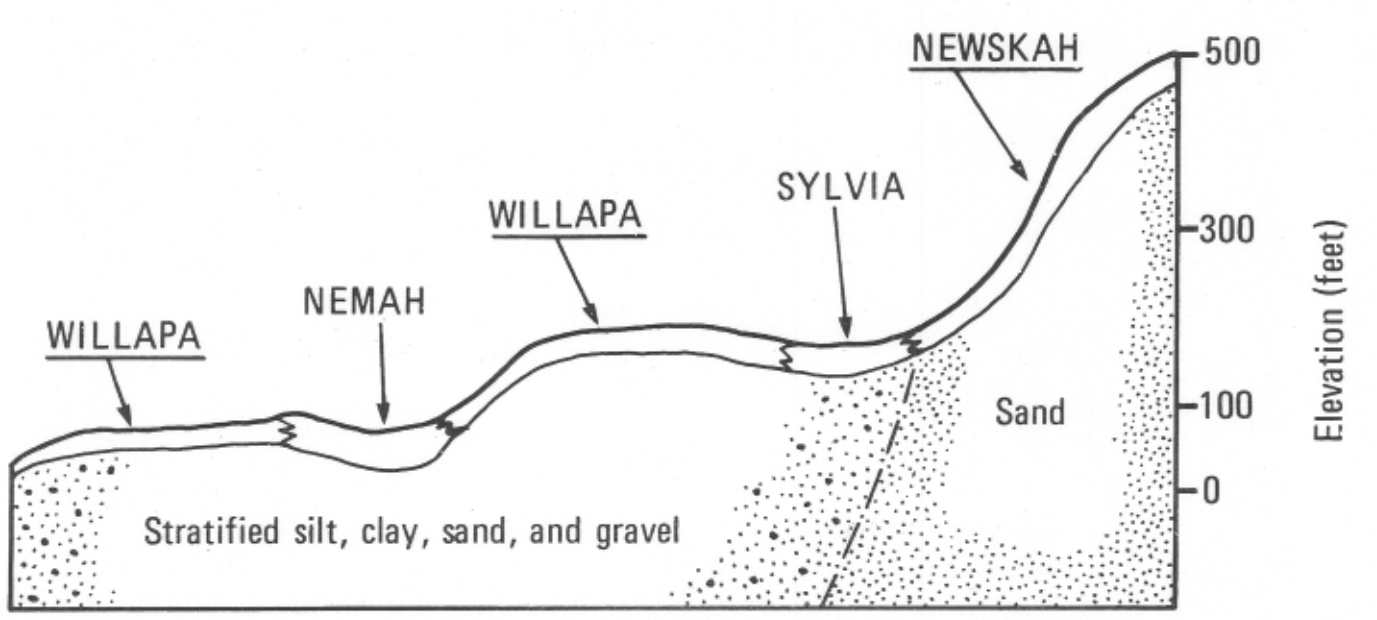

Figure 9.-Pattern of soils and parent material in general soil map unit 10.

The well drained Newskah soils are on broad ridgetops and back slopes of marine terraces. They formed in sandy marine sediment. Slope is 1 to 90 percent. The surface is covered with a mat of moss, needles, and twigs. The surface layer and subsoil are loam. The substratum to a depth of 60 inches or more is loamy fine sand.

Of minor extent in this unit are areas of well drained Knappton soils, poorly drained Nemah soils, moderately well drained Sylvia soils, and well drained Vesta soils.

This unit is used mainly as woodland, recreation areas, and wildlife habitat. It is also used as rural homesites. This unit is well suited to use as woodland, recreation areas, and wildlife habitat. If the unit is used for homesite development, the main limitation is steepness of slope.

Soils on uplands and mountains

Three map units are on these landscape positions. They make up about 21 percent of the survey area.

11. Raught-Germany

Very deep, well drained, nearly level to extremely steep soils; on uplands

This map unit is in the eastern part of the survey area. Slope is 1 to 90 percent. The vegetation is mainly conifers. Elevation is 100 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

This unit makes up about 4 percent of the survey area. It is about 25 percent Raught soils and 20 percent Germany soils. The remaining 55 percent is components of minor extent (fig. 10).

The Raught soils are on shoulders and back slopes on uplands. Slope is 5 to 90 percent. The Germany soils are on plateaus, shoulders, and back slopes on uplands. Slope is 1 to 65 percent. The soils formed in residuum and colluvium derived dominantly from basic igneous rock. The surface of both soils is covered with a mat of leaves. The surface layers are silt loam, and the subsoils to a depth of 60 inches or more are silt loam.

Of minor extent in this unit are areas of well drained Cathlamet, Schneider, and Tebo soils, and Umbric Dystrochrepts. Poorly drained Stimson soils are also included.

This unit is used mainly as woodland and wildlife habitat. It is also used for hay, pasture, and rural homesites. This unit is well suited to use as woodland. If the unit is used for hay, pasture, or homesite development, the main limitation is steepness of slope.

12. Bunker-Knappton

Deep, well drained, sloping to extremely steep soils; on uplands

This map unit is on uplands throughout the survey area. Slope is 5 to 90 percent. The vegetation is mainly

conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is 48 to 50 degrees F, and the average growing season (at 28 degrees) is 180 to 240 days.

This unit makes up about 14 percent of the survey area. It is about 35 percent Bunker soils and 25 percent Knappton soils. The remaining 40 percent is components of minor extent (fig. 11).

The Bunker and Knappton soils are on side slopes on uplands. Bunker soils have slopes of 5 to 90 percent, and Knappton soils have slopes of 8 to 90 percent. The soils formed in colluvium derived dominantly from basic igneous rock. The surface of the Bunker soils is covered with a mat of leaves. The surface layer is silt loam, and the subsoil is gravelly silt loam. Basalt is at a depth of about 50 inches. The surface of the Knappton soils is covered with a mat of needles and twigs. The surface layer is silt loam. The subsoil is gravelly silt loam and gravelly silt clay loam. Basalt is at a depth of about 43 inches. Depth to weathered basalt ranges from 40 to 60 inches or more.

Of minor extent in this unit are areas of very deep Boistfort soils, moderately deep Katula soils, very deep Squally soils, moderately deep Traham soils, very deep Vesta soils, and deep Zyzyl soils.

This unit is used as woodland and wildlife habitat. It is well suited to use as woodland.

13. Lates-Murnen

Moderately deep and very deep, well drained, sloping to extremely steep soils; on mountains

This map unit is in the eastern part of the survey area. Slope is 5 to 90 percent. The vegetation is mainly conifers. Elevation is 1,800 to 2,700 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 44 degrees F, and the average growing season (at 28 degrees) is 150 to 180 days.

This unit makes up about 3 percent of the survey area. It is about 35 percent Lates soils and 10 percent Murnen soils. The remaining 55 percent is components of minor extent (fig. 12).

The moderately deep Lates soils formed in residuum derived dominantly from basic igneous rock. Slope is 8 to 90 percent. The surface layer is silt loam, and the subsoil is gravelly loam. Basalt is at a depth of 35 inches. Depth to basalt ranges from 20 to 40 inches.

The very deep Murnen soils formed in residuum derived dominantly from basic igneous rock. Slope is 5 to 65 percent. The surface is covered with a mat of leaves. The soils are silt loam to a depth of 60 inches or more.

Of minor extent in this unit are areas of Bunker, Katula, Knappton, and Traham soils.

This unit is used as woodland and wildlife habitat. It is well suited to use as woodland.

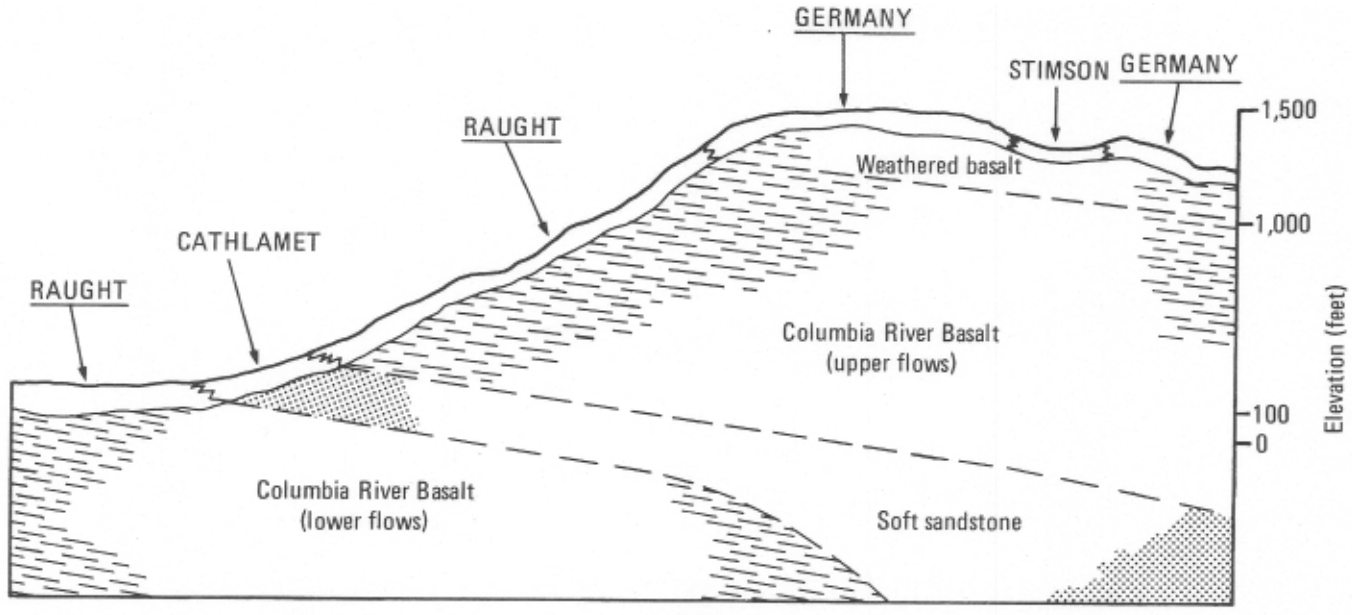

Figure 10.-Pattern of soils and parent material in general soil map unit 11.

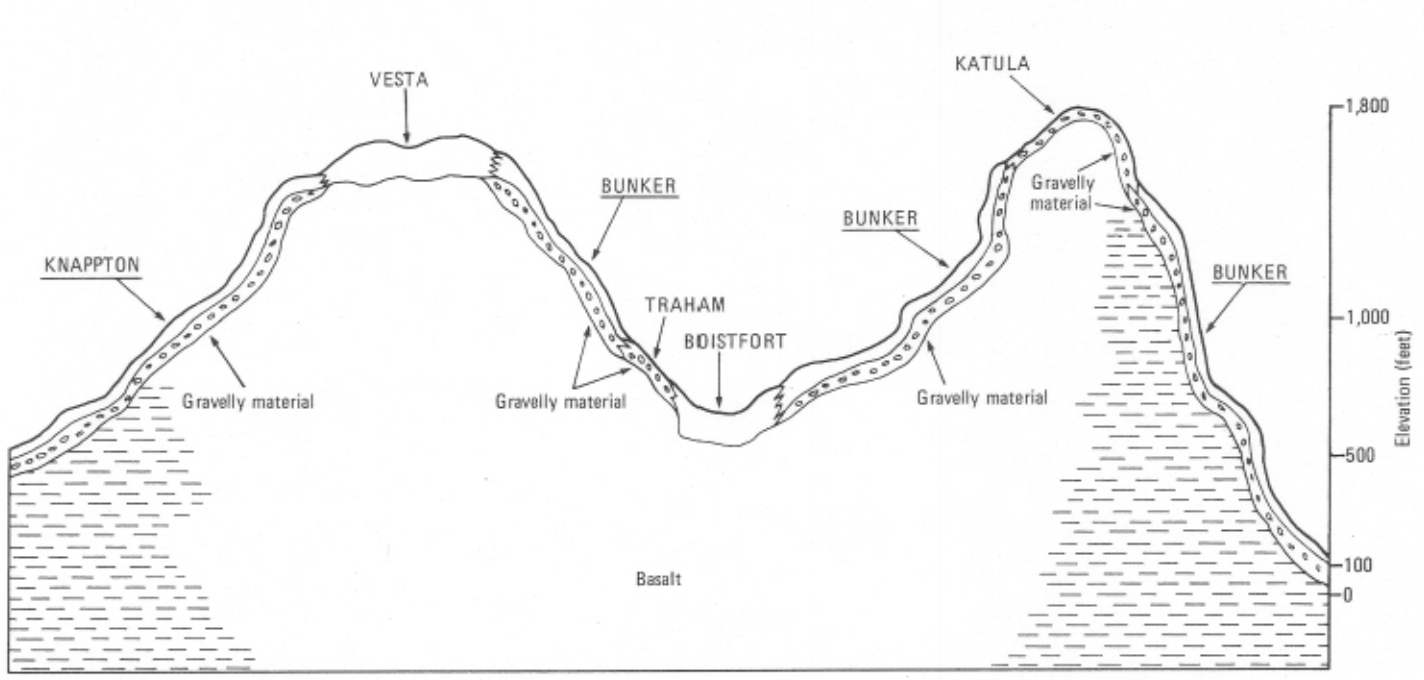

Figure 11.-Pattern of soils and parent material in general soil map unit 12.

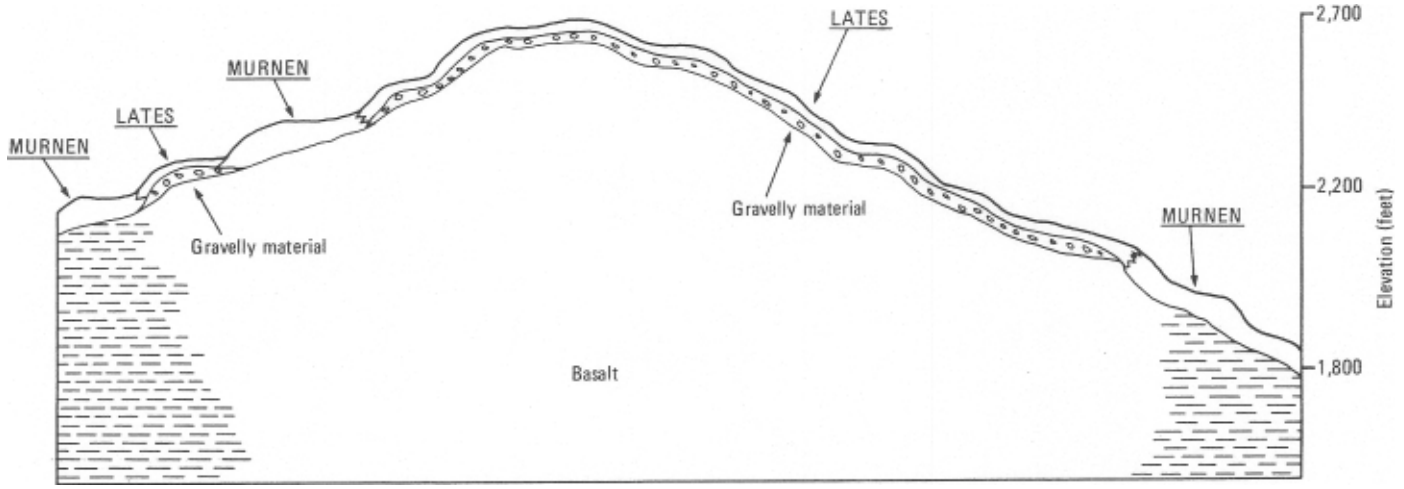

Figure 12.-Pattern of soils and parent material in general soil map unit 13.

Broad Land Use Considerations

The general soil map is useful in determining the potential of the soils in an area for a general land use pattern. It is not, however, suitable for selecting a specific site for a specific use or for designing management programs for individual farms. Specific information appropriate for designing a detailed land use plan is given in the section "Detailed Soil Map Units" and in the tables.

Approximately 90 percent of the survey area is used for commercial timber. Productivity of western hemlock

and Douglas-fir is very high in general soil map units 5, 7, 8, 10, 11, 12, and 13, and it is high in unit 6. Productivity of Douglas-fir is very high in map unit 9.

Because of the extreme steepness of most of the soils that are used for timber, logging roads should be constructed carefully to avoid soil erosion and reduce sedimentation of streams. Heavy tracked or wheeled equipment should be used only during the dry summer months. Use of this equipment when the soil is moist compacts the soil and creates ruts.

About 6 percent in the survey area is used for hay, pasture and silage, sweet corn, corn silage, peas, small grain, and cranberries. Areas of cropland are scattered throughout the survey area but are concentrated in general soil map units 1, 2, 3, and 4. The soils in map units 1, 2, and 3 are subject to flooding during winter. Because flooding occurs in winter after row crops are harvested, crop damage is minimal. In poorly drained areas and depressional areas, perennial grasses and fall-planted small grain can be severely damaged. Orcas and Seastrand soils in unit 4 are the main soils that are used for cranberries.

About 38,000 acres in the survey area has been classified as urban or built-up land. The nearly level to sloping Netarts, Nordby, and Spanaway soils, mainly in map units 3, 4, and 5, generally have high potential for urban uses. If soils in other units are used for urban development, the main limitations are low bearing strength, wetness, and steepness of slope. Soils on flood plains, such as those in map units 1 and 2 and in parts of unit 3, have low potential for urban development.

The potential of the soils for use as recreation areas ranges from low to high, depending on the expected use and its intensity and on the properties of the soils. Most of the soils in map unit 4 have high potential for intensive recreation use. Soils in units 1 and 2 and in parts of unit 3 have low potential because they are susceptible to flooding. Steepness of slope limits the soils in map units 5, 6, 7, 8, 9, 10, 11, 12, and 13 for intensive recreation uses, such as playgrounds and camping areas. Soils in all the units, however, are suitable for extensive recreation uses, such as hiking or horseback riding. Small areas suitable for intensive development may be included in map units that mainly have low potential for recreation development.

The potential of the soils for use as wildlife habitat generally is high throughout the survey area. The soils in map units 1, 2, 3, and 4 have high potential for openland wildlife habitat, and the soils in map units 5, 6, 7, 8, 9, 10, 11, 12, and 13 have high potential for woodland wildlife habitat. Some of the soils on flood plains in map units 1, 2, and 3 have high potential for wetland wildlife habitat.

Detailed Soil Map Units

The map units delineated on the detailed maps at the back of this survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this section, along with the maps, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit is given under "Use and Management of the Soils."

A map unit delineation on a map represents an area dominated by one of more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils or miscellaneous areas. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some "included" areas that belong to other taxonomic classes.

Most included soils and miscellaneous areas have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, inclusions. They may or may not be mentioned in the map unit description. Other included soils and miscellaneous areas, however, have properties and behavior divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, inclusions. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The included areas of contrasting soils or miscellaneous areas are mentioned in the map unit descriptions. A few included areas may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but if intensive use of small areas is planned, onsite investigation to precisely define and locate the soils and miscellaneous areas is needed.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up *a soil series.* Except for differences in texture of the surface layer or of the underlying layers, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying layers. They also can differ in slope, stoniness, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Elochoman silt loam, 8 to 30 percent slopes, is one of several phases in the Elochoman series.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Dune land is an example.

This survey was mapped at two levels of detail. At the most detailed level, map units are narrowly defined. This means that map unit boundaries were plotted and verified at closely spaced intervals. At the less detailed level, map units are broadly defined. Boundaries were plotted and verified at wider intervals. The broadly defined units are indicated by an asterisk in the map legend. The detail of mapping was selected to meet the anticipated long-term use of the survey, and the map units were designed to meet the needs for that use.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations,

capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

Map Unit Descriptions

1-Aabab silt loam. This very deep, somewhat poorly drained soil is on river terraces. It formed in alluvium derived from sandstone and siltstone. The slope is 0 to 3 percent. The native vegetation is mainly conifers and hardwoods. Elevation is 10 to 500 feet. The average annual precipitation is 75 to 100 inches, the average annual air temperature is about 49 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of leaves and twigs about 1 inch thick. The surface layer is dark yellowish brown silt loam about 11 inches thick. The subsoil is mottled, dark yellowish brown, brown, and yellowish brown silty clay loam about 32 inches thick. The substratum to a depth of 60 inches or more is mottled, greenish gray silty clay loam.

Included in this unit are about 10 percent Grehalem soils, 5 percent Humptulips soils, and 2 percent Nuby soils.

Permeability of this Aabab soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 12 to 30 inches from October to March. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to rare periods of flooding.

This unit is used as woodland.

Red alder is the principal forest species on this unit. Trees of limited extent include western hemlock, Sitka spruce, Douglas-fir, and western redcedar. On the basis of a 50-year site curve, the mean site index for red alder is 100. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is 118 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. The seasonal high water table restricts the use of equipment to the dry summer months.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting western hemlock, Sitka spruce, or western redcedar. If seed trees are present, natural reforestation by red alder occurs readily. The seasonal high water table reduces root respiration and increases seedling mortality. If openings are made in the canopy, invading brushy plants can delay reforestation. The restricted rooting depth, caused by the high water table, frequently causes windthrow.

Common forest understory species include trailing blackberry, western swordfern, salmonberry, vine maple, and devilsclub.

This map unit is in capability subclass IIIw.

2-Arta silt loam, 0 to 3 percent slopes. This very deep, moderately well drained soil is on uplands and terraces. It formed in material derived from sandstone, siltstone, and shale. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 500 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 49 degrees F, and the average growing season (at 28 degrees) is 180 to 200 days.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 18 inches thick. The subsoil to a depth of 60 inches or more is mottled, dark brown and dark yellowish brown silty clay loam. In some areas the subsoil has thin, discontinuous, gravelly or sandy strata.

Included in this unit are about 2 percent Sylvia soils and 5 percent Astoria, Elochoman, and Bear Prairie soils. Also included in some mapped areas are as much as 5 percent Arta soils that have a gravelly surface layer and 5 percent Arta soils that have slopes of more than 3 percent.

Permeability of this Arta soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The seasonal high water table is at a depth of 24 to 42 inches in winter.

This unit is used mainly as woodland. It is also used for hay, pasture, and rural homesites.

Red alder and western hemlock are the principal forest species on this unit. Trees of limited extent include Sitka spruce, Douglas-fir, and western redcedar. On the basis of a 50-year site curve, the mean site index is 91 for red alder and about 115 for western hemlock. On the basis of a 100-year site curve, the mean site index is about 161 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is 102 cubic feet per acre per year, and for western hemlock at age 50 it is about 256 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting western

hemlock or Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can delay reforestation. The restricted rooting depth, caused by the high water table, occasionally causes windthrow.

Common forest understory species include vine maple, salmonberry, western swordfern, salal, and red huckleberry.

This unit is well suited to hay and pasture. It is also suited to row and grain crops, but the seasonal high water table is a limitation. The high water table can be lowered by installing tile drains or open ditches if adequate outlets are available. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

If this unit is used for homesite development, the main limitation is the seasonal high water table. Tile drainage can be used to lower the water table if suitable outlets are available. Septic tank absorption fields do not function properly because of wetness.

This map unit is in capability subclass IIIw.

3-Arta silt loam, 3 to 15 percent slopes. This very deep, moderately well drained soil is on uplands and terraces. It formed in material derived from sandstone, siltstone, and shale. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 500 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 49 degrees F, and the average growing season (at 28 degrees) is 180 to 200 days.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 18 inches thick. The subsoil to a depth of 60 inches or more is mottled, dark brown and dark yellowish brown silty clay loam. In some areas the subsoil has thin, discontinuous, gravelly or sandy strata.

Included in this unit is about 5 percent Astoria, Elochoman, and Lytell soils. Also included in some mapped areas are as much as 3 percent Arta soils that have a gravelly surface layer and 10 percent Arta soils that have slopes of less than 3 percent or more than 15 percent.

Permeability of this Arta soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The seasonal high water table is at a depth of 24 to 42 inches in winter.

This unit is used mainly as woodland. It is also used for hay, pasture, and rural homesites.

Red alder and western hemlock are the principal forest species on this unit. Trees of limited extent include Sitka spruce, Douglas-fir, and western redcedar. On the basis of a 50-year site curve, the mean site index is 91 for red alder and 115 for western hemlock. On the basis of a 100-year site curve, the mean site index is 161 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is 102 cubic feet per acre per year, and for western hemlock at age 50 it is 256 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting western hemlock or Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can delay reforestation. The restricted rooting depth, caused by the high water table, occasionally causes windthrow.

Common forest understory species include vine maple, salmonberry, western swordfern, salal, and red huckleberry.

This unit is well suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is required on this unit to reduce soil erosion.

If this unit is used for homesite development, the main limitations are the seasonal high water table and steepness of slope. Tile drainage can be used to lower the water table if suitable outlets are available. Septic tank absorption fields do not function properly because of wetness.

This map unit is in capability subclass IIIe.

4-Arta silt loam, 15 to 30 percent slopes. This very deep, moderately well drained soil is on uplands and terraces. It formed in material derived from sandstone, siltstone, and shale. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 500 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 49 degrees F, and the average growing season (at 28 degrees) is 180 to 200 days.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 18 inches thick. The subsoil to a depth of 60 inches or more is mottled, dark brown and dark yellowish brown silty clay loam. In some areas the subsoil has thin, discontinuous, gravelly or sandy strata.

Included in this unit is about 5 percent Astoria, Elochoman, and Lytell soils. Also included in some mapped areas is as much as 5 percent Arta soils that have slopes of less than 15 percent.

Permeability of this Arta soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The seasonal high water table is at a depth of 24 to 42 inches in winter.

This unit is used as woodland.

Red alder and western hemlock are the principal forest species on this unit. Trees of limited extent include Sitka spruce, Douglas-fir, and western redcedar. On the basis of a 50-year site curve, the mean site index is 91 for red alder and 115 for western hemlock. On the basis of a 100-year site curve, the mean site index is 161 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is 102 cubic feet per acre per year, and for western hemlock at age 50 it is 256 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting western hemlock or Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can delay reforestation. The restricted rooting depth, caused by the high water table, occasionally causes windthrow.

Common forest understory species include vine maple, salmonberry, western swordfern, salal, and red huckleberry.

This map unit is in capability subclass IVe.

5-Astoria silt loam, 3 to 8 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from siltstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 1,000 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark grayish brown silt loam about 12 inches thick. The upper 12 inches of the subsoil is dark yellowish brown silty clay loam, and the lower part to a depth of 60 inches or more is dark yellowish brown silty clay.

Included in this unit are about 5 percent Elochoman soils and 5 percent Arta soils. Also included in some mapped areas is as much as 10 percent Astoria soils that have slopes of more than 8 percent.

Permeability of this Astoria soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used for hay, pasture, or rural homesites.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, Sitka spruce, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 180 for Douglas-fir and 173 for western hemlock. On the basis of a 50-year site curve, the mean site index is 137 for Douglas-fir and 122 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 191 cubic feet per acre per year, and for western hemlock at age 50 it is 279 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include Oregongrape, Oregon oxalis, salal, salmonberry, western swordfern, and western brackenfern.

This unit is well suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is required on this unit to reduce soil erosion.

This unit is well suited to homesite development. If the unit is used for septic tank absorption fields, the limitation of moderate permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIIe.

6-Astoria silt loam, 8 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from siltstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 1,000 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F,

and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark grayish brown silt loam about 12 inches thick. The upper 12 inches of the subsoil is dark yellowish brown silty clay loam, and the lower part to a depth of 60 inches or more is dark yellowish brown silty clay.

Included in this unit are about 10 percent Lytell soils, 5 percent Elochoman soils, 2 percent Boistfort and Bunker soils, 2 percent Stimson soils, and 1 percent Swem soils. Also included in some mapped areas is as much as 15 percent Astoria soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Astoria soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, Sitka spruce, and big leaf maple. On the basis of a 100-year site curve, the mean site index is 180 for Douglas-fir and 173 for western hemlock. On the basis of a 50-year site curve, the mean site index is 137 for Douglas-fir and 122 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 191 cubic feet per acre per year, and for western hemlock at age 50 it is 279 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include Oregongrape, Oregon oxalis, salal, salmonberry, western swordfern, and western brackenfern.

This map unit is in capability subclass IVe.

7-Astoria silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from siltstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 1,000 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark grayish brown silt loam about 12 inches thick. The upper 12 inches of the subsoil is dark yellowish brown silty clay loam, and the lower part to a depth of 60 inches or more is dark yellowish brown silty clay.

Included in this unit are about 10 percent Lytell soils, 5 percent Elochoman and Zenker soils, and 2 percent Boistfort and Bunker soils. Also included in some mapped areas is as much as 10 percent Astoria soils that have slopes of less than 30 percent.

Permeability of this Astoria soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, Sitka spruce, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 180 for Douglas-fir and 173 for western hemlock. On the basis of a 50-year site curve, the mean site index is 137 for Douglas-fir and 122 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 191 cubic feet per acre per year, and for western hemlock at age 50 it is 279 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include Oregongrape, Oregon oxalis, salal, salmonberry, western swordfern, and western brackenfern.

This map unit is in capability subclass VIe.

8-Beaches. Beaches are long, narrow, nearly level strips of sandy and gravelly material (fig. 13). They are above the level of the mean tide but are swept by storm waves. They are at the base of coastal bluffs or lowlands bordering the Pacific Ocean, Grays Harbor, Willapa Bay, and at the mouth of the Columbia River.

Beaches support no vegetation and are subject to continual wave action during high tides and storms.

Included in this unit are small areas of Dune land and Ocosta soils.

This unit is used for razor clam and butter clam production, recreation areas, and wildlife habitat.

This map unit is in capability subclass VIIIw.

9-Bear Prairie silt loam, 0 to 3 percent slopes. This very deep, well drained soil is on terraces. It formed in old alluvium. The native vegetation is mainly grasses and ferns and scattered conifers and hardwoods. Elevation is 20 to 300 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 12 inches thick. The subsoil to a depth of 60 inches or more is dark brown and dark yellowish brown silty clay loam.

Included in this unit is about 5 percent Arta soils.

Permeability of this Bear Prairie soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Figure 13.-Beaches along the Pacific ocean between Copalis and Moclips.

Most areas of this unit are used as woodland. Some areas are used for hay, pasture, and rural homesites.

Douglas-fir and red alder are the principal forest species on this unit. Trees of limited extent include western hemlock, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index is 189 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 137 for Douglas-fir and 106 for red alder. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 199 cubic feet per acre per year, and for red alder at age 40 it is 128 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder and western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salmonberry, salal, western brackenfern, vine maple, and western swordfern.

This unit is well suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

This unit is well suited to homesite development. If the unit is used for septic tank absorption fields, the limitation of moderate permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIIs.

10-Boistfort silt loam, 1 to 8 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 4.5 inches thick. The surface layer is dark brown silt loam about 12 inches thick. The upper 5 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is dark brown silty clay.

Included in this unit are about 5 percent Bunker soils and 2 percent Astoria, Elochoman, Katula, Lates, and Murnen soils. Also included in some mapped areas is as much as 5 percent Boistfort soils that have slopes of more than 8 percent.

Permeability of this Boistfort soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used as rural homesites.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 170 for Douglas-fir and 161 for western hemlock. On the basis of a 50-year site curve, the mean site index is 129 for Douglas-fir and 114 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 181 cubic feet per acre per year, and for western hemlock at age 50 it is 256 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salmonberry, western swordfern, western brackenfern, salal, and vine maple.

This unit is well suited to homesite development. If the unit is used for septic tank absorption fields, the limitation of moderate permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIIe.

11-Boistfort silt loam, 8 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 4.5 inches thick. The surface layer is dark brown silt loam about 12 inches thick. The upper 5 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is dark brown silty clay.

Included in this unit are about 5 percent Bunker soils and 2 percent Astoria, Elochoman, Katula, Lates, Lytell, Murnen, and Zenker soils. Also included in some mapped areas is as much as 5 percent Boistfort soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Boistfort soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 170 for Douglas-fir and 161 for western hemlock. On the basis of a 50-year site curve, the mean site index is 129 for Douglas-fir and 114 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 181 cubic feet per acre per year, and for western hemlock at age 50 it is 256 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salmonberry, western swordfern, western brackenfern, salal, and vine maple.

This map unit is in capability subclass IVe.

12-Boistfort silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 4.5 inches thick. The surface layer is dark brown silt loam about 12 inches thick. The upper 5 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is dark brown silty clay.

Included in this unit are about 5 percent Bunker and Katula soils and 2 percent Lates and Murnen soils. Also included in some mapped areas is as much as 5 percent Boistfort soils that have slopes of less than 30 percent.

Permeability of this Boistfort soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 170 for Douglas-fir and 161 for western hemlock. On the basis of a 50-year site curve, the mean site index is 129 for Douglas-fir and 114 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 181 cubic feet per acre per year, and for western hemlock at age 50 it is 256 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salmonberry, western swordfern, western brackenfern, salal, and vine maple.

This map unit is in capability subclass VIe.

13-Buckpeak silt loam, 8 to 30 percent slopes. This deep, well drained soil is on foot slopes and shoulders of uplands. It formed in residuum and colluvium derived from siltstone and very fine sandstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 300 to 1,200 feet. The average annual precipitation is 60 to 75 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown and dark brown silt loam about 20 inches thick. The subsoil is dark yellowish brown silty clay loam about 30 inches thick. Partly consolidated siltstone is at a depth of about 50 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more. Soft angular siltstone pebbles make up 15 to 20 percent of the surface layer and 35 to 60 percent of the subsoil.

Included in this unit are about 10 percent Melbourne soils and 5 percent Centralia soils. Also included in some mapped areas is as much as 10 percent Buckpeak soils that have slopes of more than 30 percent.

Permeability of this Buckpeak soil is moderate. Available water capacity is moderate. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western hemlock, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 176, and on the basis of a 50-year site curve, the mean site index is 133. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 187 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include Oregongrape, western swordfern, salal, vine maple, and trailing blackberry.

This map unit is in capability subclass IVe.

14-Buckpeak silt loam, 30 to 65 percent slopes. This deep, well drained soil is on slumps of uplands. It formed in residuum and colluvium derived from siltstone and very fine sandstone. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is 300 to 1,200 feet. The average annual precipitation is 60 to 75 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown and dark brown silt loam about 16 inches thick. The subsoil is dark yellowish brown silty clay loam about 31 inches thick. Partly consolidated siltstone is at a depth of about 47 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more. Soft angular siltstone pebbles make up 15 to 20 percent of the surface layer and 35 to 60 percent of the subsoil.

Included in this unit are about 10 percent Melbourne soils and 5 percent Centralia soils. Also included in some mapped areas is as much as 15 percent Buckpeak soils that have slopes of less than 30 percent or more than 65 percent.

Permeability of this Buckpeak soil is moderate. Available water capacity is moderate. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western hemlock, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 176, and on the basis of a 50-year site curve, the mean site index is 133. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 187 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless

they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include Oregongrape, western swordfern, salal, vine maple, and trailing blackberry.

This map unit is in capability subclass VIe.

15-Buckpeak silt loam, 65 to 90 percent slopes. This deep, well drained soil is on slumps of uplands. It formed in residuum and colluvium derived from siltstone and very fine sandstone. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is 300 to 1,200 feet. The average annual precipitation is 60 to 75 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown and dark brown silt loam about 15 inches thick. The subsoil is dark yellowish brown silty clay loam about 25 inches thick. Partly consolidated siltstone is at a depth of about 40 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more. Soft angular siltstone pebbles make up 15 to 20 percent of the surface layer and 35 to 60 percent of the subsoil.

Included in this unit is about 20 percent Buckpeak soils that have slopes of less than 65 percent.

Permeability of this Buckpeak soil is moderate. Available water capacity is moderate. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western hemlock, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 176, and on the basis of a 50-year site curve, the mean site index is 133. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 187 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include Oregongrape, western swordfern, salal, vine maple, and trailing huckleberry.

This map unit is in capability subclass VIIe.

16-Bunker silt loam, 5 to 30 percent slopes. This deep, well drained soil is on side slopes of uplands. It formed in colluvium derived from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaf litter about 1 inch thick. The surface layer is black and dark reddish brown silt loam about 13 inches thick. The subsoil is dark yellowish brown and dark brown gravelly silt loam about 37 inches thick. Fractured basalt is at a depth of about 50 inches. Depth to basalt ranges from 40 to 60 inches or more.

Included in this unit are about 5 percent Boistfort and Katula soils, 10 percent Squally soils, and 10 percent Bunker soils that have slopes of more than 30 percent. Also included in some mapped areas is as much as 2 percent Lates, Murnen, and Swem soils.

Permeability of this Bunker soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 161 for Douglas-fir and 156 for western hemlock. On the basis of a 50-year site curve, the mean site index is 124 for Douglas-fir and 110 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 171 cubic feet per acre per year, and for western hemlock at age 50 it is 248 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked

equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Rock for road construction is readily available in areas of this unit, generally at a depth of 3 to 5 feet. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include red huckleberry, salal, western swordfern, Oregon-grape, and western brackenfern.

This map unit is in capability subclass IVe.

17-Bunker silt loam, 30 to 65 percent slopes. This deep, well drained soil is on side slopes of uplands. It formed in colluvium derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,300 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaf litter about 1 inch thick. The surface layer is black and dark reddish brown silt loam about 13 inches thick. The subsoil is dark yellowish brown and dark brown gravelly silt loam about 37 inches thick. Fractured basalt is at a depth of about 50 inches. Depth to basalt ranges from 40 to 60 inches or more.

Included in this unit are about 10 percent Katula soils, 5 percent Boistfort and Squally soils, and 10 percent Bunker soils that have slopes of less than 30 percent or more than 65 percent. Also included in some mapped areas is as much as 2 percent Swem soils.

Permeability of this Bunker soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 161 for Douglas-fir and 156 for western hemlock. On the basis of a 50-year site curve, the mean site index is 124 for Douglas-fir and 110 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 171 cubic feet per acre per year, and for western hemlock at age 50 it is 248 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 3 to 5 feet. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include red huckleberry, salal, western swordfern, Oregon-grape, and western brackenfern.

This map unit is in capability subclass VIe.

18-Bunker silt loam, 65 to 90 percent slopes. This deep, well drained soil is on side slopes of uplands. It formed in colluvium derived from basalt. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaf litter about 1 inch thick. The surface layer is black and dark reddish brown silt loam about 13 inches thick. The subsoil is dark yellowish brown and dark brown gravelly silt loam about 37 inches thick. Fractured basalt is at a depth of about 50 inches. Depth to basalt ranges from 40 to 60 inches or more.

Included in this unit are about 15 percent Katula soils, 5 percent Squally soils, and 5 percent Bunker soils that have slopes of less than 65 percent. Also included are some mapped areas of as much as 2 percent Lates soils and some areas of soils that are less than 40 inches deep to bedrock.

Permeability of this Bunker soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include

red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 161 for Douglas-fir and about 156 for western hemlock. On the basis of a 50-year site curve, the mean site index is 124 for Douglas-fir and about 110 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 171 cubic feet per acre per year, and for western hemlock at age 50 it is about 248 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 3 to 5 feet. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include red huckleberry, salal, western swordfern, Oregon-grape, and western brackenfern.

This map unit is in capability subclass VIIe.

19-Calawah silt loam, 1 to 8 percent slopes. This very deep, well drained soil is on high terraces. It formed in glaciofluvial sediment and valley fill material of mixed origin. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 400 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown and dark brown silt loam about 16 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are about 5 percent Mopang soils, 5 percent Newskah soils, and 2 percent Willapa soils. Also included in some mapped areas is as much as 10 percent Calawah soils that have slopes of more than 8 percent.

Permeability of this Calawah soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some small areas are used for hay, pasture, or rural homesites.

Western hemlock is the principal forest species on this unit. Trees of limited extent include western redcedar, Sitka spruce, red alder, and Douglas-fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 157, and on the basis of a 50-year site curve, the mean site index is 111. Yield tables indicate that the mean annum increment at culmination (CMAI) for western hemlock at age 50 is 249 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include western swordfern, salal, salmonberry, western brackenfern, and trailing blackberry.

This unit is suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is required on this unit to reduce soil erosion.

This unit is well suited to homesite development. If the unit is used for septic tank absorption fields, the limitation of moderate permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIIe.

20-Calawah silt loam, 8 to 30 percent slopes. This very deep, well drained soil is on concave side slopes of terraces. It formed in glaciofluvial sediment and valley fill material of mixed origin. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown and dark brown silt loam about 13 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are about 10 percent Mopang soils, 5 percent Newskah soils, and 2 percent Willapa soils. Also included in some mapped areas is as much as 10 percent Calawah soils that have slopes of less than 8 percent.

Permeability of this Calawah soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include western redcedar, Sitka spruce, red alder, and Douglas-fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 157, and on the basis of a 50-year site curve, the mean site index is 111. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 249 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include western swordfern, salal, salmonberry, western brackenfern, and trailing blackberry.

This map unit is in capability subclass IVe.

21-Calawah silt loam, cool, 1 to 8 percent slopes. This very deep, well drained soil is on high terraces. It formed in glaciofluvial sediment and valley fill material of mixed origin. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 200 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown and dark brown silt loam about 13 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are about 5 percent Mopang, cool, soils; 5 percent Newskah soils; and 2 percent Willapa, cool, soils. Also included in some mapped areas is as much as 10 percent Calawah, cool, soils that have slopes of more than 8 percent.

Permeability of this Calawah soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used as homesites.

Western hemlock and Sitka spruce are the principal forest species on this unit. Trees of limited extent include western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 142, and on the basis of a 50-year site curve, the mean site index is 101. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 55 is 220 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salal, western swordfern, salmonberry, western brackenfern, and trailing blackberry.

This unit is well suited to homesite development. If the unit is used for septic tank absorption fields, the limitation of moderate permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IVe.

22-Calawah silt loam, cool, 8 to 30 percent slopes. This very deep, well drained soil is on concave side slopes of terraces. It formed in glaciofluvial sediment and valley fill material of mixed origin. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 200 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown and dark brown silt loam about 13 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are about 5 percent Mopang, cool, soils; 5 percent Newskah soils; and 2 percent Willapa, cool, soils. Also included in some mapped areas is as much as 10 percent Calawah, cool, soils that have slopes of less than 8 percent.

Permeability of this Calawah soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock and Sitka spruce are the principal forest species on this unit. Trees of limited extent include western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 142, and on the basis of a 50-year site curve, the mean site index is 101. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 55 is 220 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salal, western swordfern, salmonberry, western brackenfern, and trailing blackberry.

This map unit is in capability subclass IVe.

23-Carstairs very gravelly loam, 1 to 8 percent slopes. This very deep, somewhat excessively drained soil is on glacial outwash terraces. It formed in extremely gravelly glacial outwash. The native vegetation is mainly grasses, ferns, and scattered conifers. Elevation is 100 to 200 feet. The average annual precipitation is 70 to 80 inches, the average annual air temperature is 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark brown very gravelly loam about 14 inches thick. The subsoil is dark yellowish brown extremely gravelly loamy sand about 14 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown extremely gravelly sand.

Included in this unit are about 10 percent Lyre soils and 3 percent Lyre Variant soils.

Permeability of this Carstairs soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland. It is also used for hay and pasture, as rural homesites, and as a source of gravel.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include Lodgepole pine, western hemlock, western redcedar, and red alder. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 163, and on the basis of a 50-year site curve, the mean site index is 123. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 173 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are slippery. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit. This unit is well suited to year-round logging operations except during short periods when the soil is wet. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by Douglas-fir occurs infrequently. Droughtiness of the surface layer increases seedling mortality. Seedlings planted in the less fertile subsoil grow poorly and have poor vigor. If

openings are made in the canopy, invading brushy plants can delay establishment of planted seedlings.

Common forest understory species include Oregongrape, salal, Indian plum, western swordfern, western brackenfern, and kinnikinnick.

This unit is poorly suited to hay and pasture. The main limitations are the low available water capacity and low soil fertility. Because the soil is droughty, applications of water should be light and frequent. Sprinkler irrigation is a suitable method. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is well suited to homesite development. Removal of pebbles and cobbles in disturbed areas is needed for best results in landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IVs.

24-Cathiamet silt loam, 1 to 8 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from sandstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 12 inches thick. The upper 10 inches of the subsoil is dark brown silt loam, and the lower part to a depth of 60 inches or more is dark brown silty clay loam.

Included in this unit is about 5 percent Germany and Raught soils. Also included in some mapped areas are as much as 3 percent Cathlamet soils that have slopes of more than 8 percent and 5 percent soils that have a clay layer at a depth of about 40 inches.

Permeability of this Cathlamet soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used for hay, pasture, and rural homesites.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder and western redcedar. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 163 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 115 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 184 cubic feet per acre per year, and for western hemlock at age 50 it is 260 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include western swordfern, vine maple, red huckleberry, salal, and western brackenfern.

This unit is well suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is required on this unit to reduce soil erosion.

This unit is well suited to homesite development. If the unit is used for septic tank absorption fields, the limitation of moderate permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIe.

25-Cathlamet silt loam, 8 to 30 percent slopes. This very deep, well drained soil is on shoulders and back slopes of uplands. It formed in material derived from sandstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 12 inches thick. The upper 10 inches of the subsoil is dark brown silt loam, and the lower part to a depth of 60 inches or more is dark brown silty clay loam.

Included in this unit is about 5. percent Germany and Raught soils. Also included in some mapped areas are as much as 5 percent Cathlamet soils that have slopes of less than 8 percent or more than 30 percent and 2 percent soils that have a clay layer at a depth of about 40 inches.

Permeability of this Cathlamet soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder and western redcedar. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 163 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 115 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 184 cubic feet per acre per year, and for western hemlock at age 50 it is 260 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include western swordfern, vine maple, red huckleberry, salal, and western brackenfern.

This map unit is in capability subclass IVe.

26-Cathiamet silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on concave back slopes of uplands. It formed in material derived from sandstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 12 inches thick. The upper 10 inches of the subsoil is dark brown silt loam, and the lower part to a depth of 60 inches or more is dark brown silty clay loam.

Included in this unit is about 5 percent Germany and Raught soils. Also included in some mapped areas are as much as 10 percent Cathlamet soils that have slopes of less than 30 percent and 5 percent soils that have a clay layer at a depth of about 40 inches.

Permeability of this Cathlamet soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder and western redcedar. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 163 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 115 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 184 cubic feet per acre per year, and for western hemlock at age 50 it is 260 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include western swordfern, vine maple, red huckleberry, salal, and western brackenfern.

This map unit is in capability subclass VIe.

27-Centralia loam, 1 to 8 percent slopes. This very deep, well drained soil is on broad ridgetops, small plateaus, and shoulders. It formed in material derived from sandstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 200 to 1,200 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 3 inches thick. The surface layer is very dark grayish brown and dark brown loam about 16

inches thick. The subsoil is dark yellowish brown and dark brown clay loam about 34 inches thick. The substratum to a depth of 60 inches or more is dark brown loam.

Included in this unit are about 10 percent Buckpeak soils and 5 percent Melbourne soils. Also included in some mapped areas is as much as 10 percent Centralia soils that have slopes of more than 8 percent.

Permeability of this Centralia soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some small areas are used for hay, pasture, or rural homesites.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 188, and on the basis of a 50-year site curve, the mean site index is 140. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 198 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include western brackenfern, western swordfern, salal, red huckleberry, and Oregon-grape.

This unit is suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is required on this unit to reduce soil erosion.

If this unit is used for homesite development, the main limitation is shrink-swell potential. The effects of shrinking and swelling can be minimized by using proper engineering designs and backfilling with material that has low shrink-swell potential. If this unit is used for septic tank absorption fields, the limitation of moderate permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIe.

28-Centralia loam, 8 to 30 percent slopes. This very deep, well drained soil is on back slopes of uplands. It formed in material derived from sandstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 200 to 1,100 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 3 inches thick. The surface layer is very dark grayish brown and dark brown loam about 14 inches thick. The subsoil is dark yellowish brown and dark brown clay loam about 36 inches thick. The substratum to a depth of 60 inches or more is dark brown loam.

Included in this unit are about 5 percent Melbourne soils and 5 percent Buckpeak soils. Also included in some mapped areas is as much as 10 percent Centralia soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Centralia soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 180, and on the basis of a 50-year site curve, the mean site index is 135. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 191 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include western swordfern, western brackenfern, salal, red huckleberry, and Oregon-grape.

This map unit is in capability subclass IVe.

29-Centralia loam, 30 to 65 percent slopes. This very deep, well drained soil is on back slopes and foot slopes of uplands. It formed in material derived from sandstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 200 to 1,000 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 3 inches thick. The surface layer is very dark grayish brown and dark brown loam about 10 inches thick. The subsoil is dark yellowish brown and dark brown clay loam about 38 inches thick. The substratum to a depth of 60 inches or more is dark brown loam.

Included in this unit are about 15 percent Buckpeak soils and 5 percent Melbourne soils. Also included in some mapped areas is as much as 10 percent Centralia soils that have slopes of less than 30 percent.

Permeability of this Centralia soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 180, and on the basis of a 50-year site curve, the mean site index is 135. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 191 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings.

Common forest understory species include western swordfern, western brackenfern, salal, red huckleberry, and Oregon-grape.

This map unit is in capability subclass VIe.

30-Chehalis silt loam. This very deep, well drained soil is on natural levees of flood plains. It formed in alluvium. The slope is 0 to 3 percent. The native vegetation is mainly conifers. Elevation is 50 to 200 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 52 degrees F, the average growing season (at 28 degrees) is 200 to 220 days, and the average frost-free season (at 32 degrees) is 150 to 210 days.

Typically, the surface layer is very dark grayish brown and dark brown silt loam about 12 inches thick. The upper 12 inches of the subsoil is dark brown silt loam, and the lower 28 inches is dark brown silty clay loam. The substratum to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are about 10 percent Newberg soils, 10 percent Cloquato soils, and 5 percent Rennie soils. Also included in some mapped areas is as much as 5 percent Salzer soils.

Permeability of this Chehalis soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional, brief periods of flooding in winter.

Most areas of this unit are used for cultivated crops or for hay or pasture (fig. 14). Some small areas are used as rural homesites or woodland.

This unit is well suited to hay, pasture, and cultivated crops. The main limitation is the hazard of flooding. Flooding can be controlled by diking adjacent streams or diverting upland runoff away from the area. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

Sweet corn, corn silage, and peas are commonly grown on this unit. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method. Returning all crop residue and green manure crops to the soil helps to maintain fertility and tilth.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, grand fir, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is about 173, and on the basis of a 50-year site curve, the mean site index is about 130. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is about 184 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. Unsurfaced roads and skid trails are soft and sticky, and they generally are impassable when wet. Logging roads require suitable surfacing for year-round use. Rock for

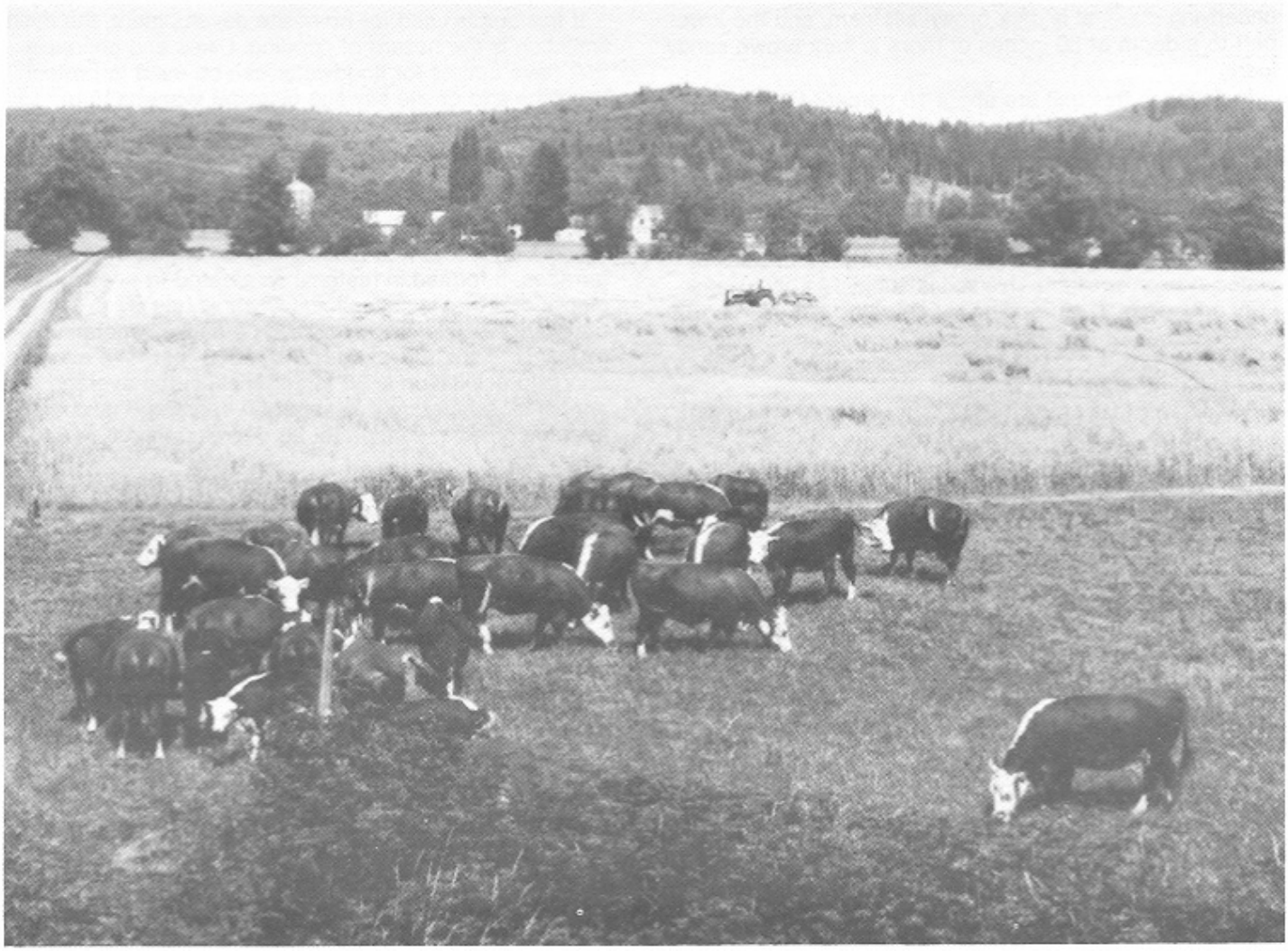

Figure 14.-Beef cattle on Chehalis silt loam. These soils are in Grays Harbor County.

road construction is not readily available in areas of this unit.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. Occasional, brief floods reduce root respiration and seedling survival. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include western swordfern, vine maple, western brackenfern, Oregongrape, and trailing blackberry.

If this unit is used for homesite development, the main limitation is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be located above the expected flood level.

This map unit is in capability subclass IIw.

31-Cloquato silt loam. This very deep, well drained soil is on natural levees of flood plains. It formed in alluvium. The slope is 0 to 3 percent. The native vegetation is mainly conifers. Elevation is 50 to 150 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 52 degrees F, the average growing season (at 28 degrees) is 200 to 220 days, and the average frost-free season (at 32 degrees) is 150 to 210 days.

Typically, the surface layer is dark brown silt loam about 36 inches thick. The upper 21 inches of the

underlying material is dark brown silt loam, and the lower part to a depth of 60 inches or more is dark brown sandy loam.

Included in this unit are about 10 percent Chehalis soils and 10 percent Newberg soils. Also included in some mapped areas is as much as 5 percent Rennie and Salzer soils.

Permeability of this Cloquato soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional, very brief periods of flooding in winter.

Most areas of this unit are used for cultivated crops or for hay or pasture. Some small areas are used as rural homesites or woodland.

This unit is well suited to hay, pasture, and cultivated crops. The main limitation is the hazard of flooding. Flooding can be controlled by diking adjacent streams or diverting upland runoff away from the area. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

Sweet corn, corn silage, and peas are commonly grown on this unit. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method. Returning all crop residue and green manure crops to the soil helps to maintain fertility and tilth.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is about 173, and on the basis of a 50-year site curve, the mean site index is about 130. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is about 184 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. Unsurfaced roads and skid trails are soft and sticky, and they generally are impassable when wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. Occasional, very brief floods reduce root respiration and seedling survival. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include willow, vine maple, western brackenfern, Oregon-grape, and trailing blackberry.

If this unit is used for homesite development, the main limitation is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be located above the expected flood level.

This map unit is in capability subclass IIw.

32-Copalis silt loam, 1 to 8 percent slopes. This moderately deep, well drained soil is on glaciofluvial terraces. It formed in material weathered from piedmont glacial drift that includes local Olympic basalt, graywacke, shale, and argillite. The native vegetation is mainly conifers. Elevation is 30 to 800 feet. The average annual precipitation is 80 to 140 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, bark, and moss about 1.5 inches thick. The surface layer is dark reddish brown and dark brown silt loam about 11 inches thick. The subsoil is dark reddish brown silt loam about 15 inches thick. The substratum is strong brown silt loam about 12 inches thick. Dense glacial drift that crushes to extremely gravelly loamy sand is at a depth of about 38 inches. Depth to the glacial drift ranges from 20 to 40 inches.

Included in this unit are about 20 percent Mopang soils, 5 percent Halbert and Nemah soils, 5 percent Hoquiam and Le Bar soils, and 3 percent Nordby, O'Brien, and Willaby soils. Also included is 10 percent Copalis soils that have slopes of more than 8 percent.

Permeability of this Copalis soil is moderate to the dense glacial drift and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. The effect of the drift layer on use and management is similar to the effect of a hardpan.

Most areas of this unit are used as woodland. Some small areas are used for hay, pasture, or rural homesites.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include Sitka spruce, red alder, and western redcedar. On the basis of a 100-year site curve, the mean site index is 165 for Douglas-fir and 159 for western hemlock. On the basis of a 50-year site curve, the mean site index is 126 for Douglas-fir and 113 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 176 cubic feet per acre per year, and for western hemlock at age 50 it is 252 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round

use. Rock for road construction is readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and delay natural regeneration of western hemlock. Because rooting depth is restricted by the underlying dense glacial drift, trees are subject to occasional windthrow.

Common forest understory species include western swordfern, western brackenfern, salal, vine maple, and cascara buckthorn.

This unit is suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is required on this unit to reduce soil erosion.

If this unit is used for homesite development, the main limitation is the dense glacial drift at a depth of 20 to 40 inches. The glacial drift is rippable and therefore is not a serious limitation for most engineering uses. Because of the very slow permeability of the drift, onsite sewage disposal systems often do not function properly.

This map unit is in capability subclass IIIe.

33-Copalis silt loam, 8 to 30 percent slopes. This moderately deep, well drained soil is on glaciofluvial terraces. It formed in weathered piedmont glacial drift that includes local Olympic basalt, graywacke, shale, and argillite. The native vegetation is mainly conifers. Elevation is 30 to 800 feet. The average annual precipitation is 80 to 140 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, bark, and moss about 1.5 inches thick. The surface layer is dark reddish brown and dark brown silt loam about 8 inches thick. The subsoil is dark reddish brown silt loam about 17 inches thick. The substratum is strong brown silt loam about 12 inches thick. Dense glacial drift that crushes to extremely gravelly loamy sand is at a depth of about 37 inches. Depth to the glacial drift ranges from 20 to 40 inches.

Included in this unit are about 20 percent Mopang soils, 10 percent Hoquiam and Le Bar soils, and 3 percent Nordby, O'Brien, and Willaby soils. Also included is 10 percent Copalis soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Copalis soil is moderate to the dense glacial drift and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. The effect of the drift layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include Sitka spruce, red alder, and western redcedar. On the basis of a 100-year site curve, the mean site index is 165 for Douglas-fir and 159 for western hemlock. On the basis of a 50-year site curve, the mean site index is 126 for Douglas-fir and 113 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 176 cubic feet per acre per year, and for western hemlock at age 50 it is 252 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and delay natural regeneration of western hemlock. Because rooting depth is restricted by the underlying dense glacial drift, trees are subject to occasional windthrow.

Common forest understory species include western swordfern, western brackenfern, salal, vine maple, and cascara buckthorn.

This map unit is in capability subclass IVe.

34-Copalis silt loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on glaciofluvial terraces. It formed in weathered piedmont glacial drift that includes local Olympic basalt, graywacke, shale, and argillite. The native vegetation is mainly conifers. Elevation is 30 to 800 feet. The average annual precipitation is 80 to 140 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, bark, and moss about 1.5 inches thick. The surface layer is dark reddish brown and dark brown silt loam about 6 inches thick. The subsoil is dark reddish brown silt loam about 15 inches thick. The substratum is strong brown silt loam about 15 inches thick. Dense glacial drift that crushes to extremely gravelly loamy

sand is at a depth of about 36 inches. Depth to the glacial drift ranges from 20 to 40 inches.

Included in this unit are about 20 percent Mopang soils, 10 percent Hoquiam and Le Bar soils, and 5 percent Nordby soils. Also included is 10 percent Copalis soils that have slopes of less than 30 percent.

Permeability of this Copalis soil is moderate to the dense glacial drift and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The effect of the drift layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include Sitka spruce, red alder, and western redcedar. On the basis of a 100-year site curve, the mean site index is 165 for Douglas-fir and 159 for western hemlock. On the basis of a 50-year site curve, the mean site index is 126 for Douglas-fir and 113 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 176 cubic feet per acre per year, and for western hemlock at age 50 it is 252 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and delay natural regeneration of western hemlock. Because rooting depth is restricted by the underlying dense glacial drift, trees are subject to occasional windthrow.

Common forest understory species include western swordfern, western brackenfern, salal, vine maple, and cascara buckthorn.

This map unit is in capability subclass VIe.

35-Dune land. This very deep, dominantly excessively drained land type consists of a ridge of dunes near the ocean shore, an interdune area, and a ridge of dunes inward from the ocean shore. Dunes nearer the shore generally form a narrow ridge that is 5 to 30 feet high and is parallel to the coastline. The interdune area is nearly level and has a water table that is at the surface during the rainy season. The dunes inward from the ocean shore form a ridge 20 to 60 feet high. The dunes are constantly shifted by strong coastal winds.

Dune land formed in fine sand. The slope is 0 to 30 percent. The native vegetation is very sparse beachgrass. Elevation is sea level to 60 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is about 50 degrees F, the average growing season (at 28 degrees) is 200 to 240 days, and the average frost-free season (at 32 degrees) is 150 to 200 days.

A commonly observed profile of Dune land is grayish brown fine sand to a depth of 60 inches or more.

Included in this unit is about 10 percent Westport soils.

Permeability of Dune land is dominantly very rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe.

This unit is used for recreation and as homesites.

This unit is poorly suited to homesite development. The main limitations are the hazard of soil blowing and the high water table in the interdune area. In some places, excavation for houses and access roads exposes material that is highly susceptible to soil blowing. Disturbed areas around construction sites should be revegetated as soon as possible to reduce soil blowing. Shifting sand can be stabilized by planting beachgrass followed by Scotch-broom and shore pine (fig. 15). In summer, irrigation is required for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage.

This map unit is in capability subclass VIIIe.

36-Elochoman silt loam, 1 to 8 percent slopes. This very deep, well drained soil is on broad ridgetops, small plateaus, and shoulders of uplands. It formed in material derived from sandstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark brown and dark brown silt loam about 21 inches thick. The subsoil to a depth of 60 inches or more is yellowish brown silt loam.

Included in this unit are about 2 percent Astoria soils, 2 percent Montesa soils, and 2 percent Stimson soils.

Figure 15.-Beachgrass on Dune land in Pacific County.

Also included in some mapped areas is as much as 3 percent Elochoman soils that have slopes of more than 8 percent.

Permeability of this Elochoman soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used as rural homesites.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, Sitka spruce, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 178 for Douglas-fir and for western hemlock. On the basis of a 50-year site curve, the mean site index is 136 for Douglas-fir and 124 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 189 cubic feet per acre per year, and for western hemlock at age 50 it is 288 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable.

Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, western swordfern, western brackenfern, vine maple, and salmonberry.

This unit is well suited to homesite development. If the unit is used for septic tank absorption fields, the limitation of moderate permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIIe.

37-Elochoman silt loam, 8 to 30 percent slopes. This very deep, well drained soil is on back slopes of uplands. It formed in material derived from sandstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark brown and dark brown silt loam about 18 inches thick. The subsoil to a depth of 60 inches or more is yellowish brown silt loam.

Included in this unit are about 10 percent Zenker soils, 2 percent Lytell soils, and 5 percent Astoria soils. Also included in some mapped areas is as much as 5 percent Elochoman soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Elochoman soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, Sitka spruce, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 178 for Douglas-fir and for western hemlock. On the basis of a 50-year site curve, the mean site index is 136 for Douglas-fir and 124 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 189 cubic feet per acre per year, and for western hemlock at age 50 it is 288 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, western swordfern, western brackenfern, vine maple, and salmonberry.

This map unit is in capability subclass IVe.

38-Elochoman silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on back slopes and foot slopes of uplands. It formed in material derived from sandstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark brown and dark brown silt loam about 17 inches thick. The subsoil to a depth of 60 inches or more is yellowish brown silt loam.

Included in this unit are about 10 percent Zenker soils and 5 percent Astoria and Lytell soils. Also included in some mapped areas is as much as 5 percent Elochoman soils that have slopes of less than 30 percent.

Permeability of this Elochoman soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, Sitka spruce, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 178 for Douglas-fir and for western hemlock. On the basis of a 50-year site curve, the mean site index is 136 for Douglas-fir and 124 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 189 cubic feet per acre per year, and for western hemlock at age 50 it is 288 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, western swordfern, western brackenfern, vine maple, and salmonberry.

This map unit is in capability subclass VIe.

39-Fluvaquents, tidal. This very deep, very poorly drained soil is on flood plains and deltas. It formed in alluvium. The slope is 0 to 1 percent. The native vegetation is sparse grasses and salt tolerant plants. Elevation is sea level to 10 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

No single profile is representative of Fluvaquents, tidal, but one commonly observed in the survey area has a dark olive gray very fine sand surface layer about 6 inches thick. The underlying material to a depth of 60 inches or more is very dark gray loamy very fine sand. The underlying material ranges from loamy very fine sand to silty clay.

Permeability of Fluvaquents, tidal, is slow to moderately rapid. Available water capacity is moderately high. Effective rooting depth is limited by a high water table that is between a depth of 1 foot and the surface during periods of high tide. Runoff is very slow, and the hazard of water erosion is none. This soil is subject to frequent, very brief periods of flooding during high tides.

This unit is used as wildlife habitat and for recreation.

This map unit is in capability subclass VIIIw.

40-Germany silt loam, 1 to 8 percent slopes. This very deep, well drained soil is on broad, convex shoulders and plateaus of uplands. It formed in loess and weathered basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 400 to 1,500 feet. The average annual precipitation is 55 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 220 to 240 days.

Typically, the surface is covered with a mat of leaves and twigs about 3 inches thick. The surface layer is dark brown silt loam about 24 inches thick. The subsoil to a depth of 60 inches or more is dark brown silt loam.

Included in this unit are about 2 percent Raught and Cathlamet soils and 2 percent Stimson soils. Also included in some mapped areas is as much as 5 percent Germany soils that have slopes of more than 8 percent.

Permeability of this Germany soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used for hay, pasture, or rural homesites.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 163 for Douglas-fir and 165 for western hemlock. On the basis of a 50-year site curve, the mean site index is 125 for Douglas-fir and 116 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 173 cubic feet per acre per year, and for western hemlock at age 50 it is 264 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include western swordfern, western brackenfern, salal, salmonberry, and Oregon-grape.

This unit is suited to strawberries, cane fruit, nuts, and grain.

This unit is suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is required on this unit to reduce soil erosion.

This unit is well suited to homesite development. If the unit is used for septic tank absorption fields, the limitation of moderate permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIe.

41-Germany silt loam, 8 to 30 percent slopes. This very deep, well drained soil is on convex shoulders of uplands. It formed in loess and weathered basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 400 to 1,500 feet. The average annual precipitation is 55 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 220 to 240 days.

Typically, the surface is covered with a mat of leaves and twigs about 3 inches thick. The surface layer is dark brown silt loam about 26 inches thick. The subsoil to a depth of 60 inches or more is dark brown silt loam.

Included in this unit are about 5 percent Raught soils, 2 percent Cathlamet soils, 2 percent Stimson soils, and 5 percent Germany soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Germany soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 163 for Douglas-fir and 165 for western hemlock. On the basis of a 50-year site curve, the mean site index is 125 for Douglas-fir and 116 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 173 cubic feet per acre per year, and for western hemlock at age 50 it is 264 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include western swordfern, western brackenfern, salal, salmonberry, and Oregon-grape.

This map unit is in capability subclass IVe.

42-Germany silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on shoulders and back slopes of uplands. It formed in loess and material weathered from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 400 to 1,500 feet. The average annual precipitation is 55 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 220 to 240 days.

Typically, the surface is covered with a mat of leaves and twigs about 3 inches thick. The surface layer is dark brown silt loam about 20 inches thick. The subsoil to a depth of 60 inches or more is dark brown silt loam.

Included in this unit are about 10 percent Raught soils, 5 percent Cathlamet soils, and 3 percent Germany soils that are gravelly below the surface layer or have fractured basalt at a depth of less than 60 inches. Also included in some mapped areas is as much as 5 percent Germany soils that have slopes of less than 30 percent.

Permeability of this Germany soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 163 for Douglas-fir and 165 for western hemlock. On the basis of a 50-year site curve, the mean site index is 125 for Douglas-fir and 116 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 173 cubic feet per acre per year, and for western hemlock at age 50 it is 264 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent the establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include western swordfern, western brackenfern, salal, salmonberry, and Oregon-grape.

This map unit is in capability subclass VIe.

43-Grehalem silt loam. This very deep, well drained soil is on natural levees of flood plains. It formed in alluvium. The slope is 0 to 3 percent. The native vegetation is mainly conifers. Elevation is 10 to 100 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, the average growing season (at 28 degrees) is 180 to 220 days, and the average frost-free season (at 32 degrees) is 150 to 200 days.

Typically, the surface layer is dark brown silt loam about 8 inches thick. The underlying material to a depth of 60 inches or more is mainly dark brown and dark yellowish brown silty clay loam. It is weakly stratified with very fine sandy loam to clay loam.

Included in this unit are about 5 percent Nuby soils and 2 percent Humptulips soils. Also included in some mapped areas is as much as 5 percent Aabab soils.

Permeability of this Grehalem soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional, brief periods of flooding in winter.

Most areas of this unit are used for cultivated crops or for hay or pasture (fig. 16). Some areas are used as woodland or rural homesites.

This unit is well suited to hay, pasture, and cultivated crops. The main limitation is the hazard of flooding. Flooding can be controlled by diking adjacent streams or diverting upland runoff away from the area. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

Corn silage is commonly grown on this unit. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method. Returning all crop residue to the soil and growing green manure crops help to maintain fertility and tilth.

Douglas-fir and red alder are the principal forest species on this unit. Trees of limited extent include western hemlock, western redcedar, grand fir, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is about 188, and on the basis of a 50-year site curve, the mean site index is about 140. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is about 198 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. Occasional, brief floods reduce root respiration and seedling survival. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include salmonberry, salal, Oregon-grape, red elderberry, and western brackenfern.

If this unit is used for homesite development, the main limitation is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be located above the expected flood level.

This map unit is in capability subclass IIIw.

44-Halbert muck, 0 to 10 percent slopes. This shallow, poorly drained soil is on glacial outwash plains. It formed in glaciolacustrine sediment deposited over glacial outwash. The native vegetation is mainly conifers. Elevation is 50 to 500 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles and twigs about 5 inches thick. The upper layer is black muck about 11 inches thick. The next layer is mottled, very dark brown and dark grayish brown silty clay loam about 15 inches thick over a dark reddish brown, indurated, continuous iron pan about 1 inch thick. The next layer is mottled, grayish brown silty clay loam about 7 inches thick. Below this to a depth of 60 inches or more is olive gray extremely gravelly sandy loam. Depth to the iron pan ranges from 20 to 40 inches below the surface of the muck.

Included in this unit are about 5 percent O'Brien and Papac soils, 5 percent Oyhut and Willaby soils, and 10 percent Nemah soils.

Permeability of this Halbert soil is moderately slow above the iron pan and very slow through it. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that ranges from a depth of 6 inches to above the surface from October to May.

Figure 16.-Hay on Grehalem silt loam. These soils are in Grays Harbor County Area.

Runoff is slow or ponded, and the hazard of water erosion is slight.

This unit is used as woodland.

This unit is poorly suited to timber production. Western hemlock and Sitka spruce are the principal forest species. Trees of limited extent include western redcedar, western white pine, and shore pine. On the basis of a 100-year site curve, the mean site index for western hemlock is about 98, and on the basis of a 50-year site curve, the mean site index is about 70. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 118 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable.

Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit. The seasonal high water table and ponding restrict the use of equipment to the dry summer months. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment and the hazard of windthrow are the main concerns in producing timber. Reforestation in cutover areas can be accomplished by hand planting western redcedar and Sitka spruce seedlings. If seed trees are present, natural reforestation by western redcedar and Sitka spruce occurs periodically. The seasonal high water table and ponding reduce root respiration and cause seedling mortality. If openings are made in the canopy, invading brushy plants can prevent establishment of seedlings and can delay natural

reforestation. The restricted rooting depth, caused by poor drainage and the iron pan, frequently causes windthrow.

Common forest understory species include salal, evergreen huckleberry, red huckleberry, rush, and salmonberry.

This map unit is in capability subclass VIw.

45-Hoquiam silt loam, 1 to 8 percent slopes. This deep, well drained soil is on ground moraines of uplands. It formed in old alluvium deposited over glacial drift. The native vegetation is mainly conifers. Elevation is 100 to 900 feet. The average annual precipitation is 80 to 130 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of moss, twigs, and leaves about 3 inches thick. The surface layer is dark reddish brown silt loam about 18 inches thick. The upper 11 inches of the subsoil is reddish brown silt loam, the next 17 inches is dark brown gravelly silt loam, and the lower part is dark brown gravelly sandy loam about 8 inches thick. Dense glacial drift is at a depth of about 54 inches. Depth to the glacial drift ranges from 40 to 55 inches.

Included in this unit are about 10 percent Le Bar soils, 5 percent Copalis soils, and 5 percent Hoquiam soils that have slopes of more than 8 percent.

Permeability of this Hoquiam soil is moderate to the dense glacial drift and very slow through it. Available water capacity is high. Effective rooting depth is 40 to 55 inches. Runoff is slow, and the hazard of water erosion is slight. The effect of the drift layer on use and management is similar to the effect of a hardpan.

Most areas of this unit are used as woodland. Some small areas are used for hay, pasture, or rural homesites.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder and western redcedar. On the basis of a 100-year site curve, the mean site index is 170 for Douglas-fir and 159 for western hemlock. On the basis of a 50-year site curve, the mean site index is 127 for Douglas-fir and 113 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 181 cubic feet per acre per year, and for western hemlock at age 50 it is 252 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles are readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, red huckleberry, western swordfern, western brackenfern, and salmonberry.

This unit is suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is required on this unit to reduce soil erosion.

If this unit is used for homesite development, the main limitation is the glacial drift. The glacial drift is rippable; therefore, it is not a serious limitation for most engineering uses. Because of this restrictive layer, onsite sewage disposal systems often fail or do not function properly.

This map unit is in capability subclass IIIe.

46-Hoquiam silt loam, 8 to 30 percent slopes. This deep, well drained soil is on ground moraines of uplands. It formed in old alluvium deposited over glacial drift. The native vegetation is mainly conifers. Elevation is 100 to 900 feet. The average annual precipitation is 80 to 130 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of moss, twigs, and leaves about 3 inches thick. The surface layer is dark reddish brown silt loam about 15 inches thick. The upper 11 inches of the subsoil is reddish brown silt loam, the next 17 inches is dark brown gravelly silt loam, and the lower part is dark brown gravelly sandy loam about 8 inches thick. Dense glacial drift is at a depth of about 51 inches. Depth to the glacial drift ranges from 40 to 55 inches.

Included in this unit are about 10 percent Le Bar soils, 5 percent Copalis soils, and 10 percent Hoquiam soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Hoquiam soil is moderate to the dense glacial drift and very slow through it. Available water capacity is high. Effective rooting depth is 40 to 55 inches. Runoff is slow, and the hazard of water erosion is slight. The effect of the drift layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder and western redcedar. On the basis of a 100-year site curve, the mean site index is 170 for Douglas-fir and 159 for western hemlock. On the basis of a 50-year site curve, the mean site index is 127 for Douglas-fir and

113 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 181 cubic feet per acre per year, and for western hemlock at age 50 it is 252 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles are readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, red huckleberry, western swordfern, western brackenfern, and salmonberry.

This map unit is in capability subclass IVe.

47-Hoquiam silt loam, 30 to 65 percent slopes. This deep, well drained soil is on ground moraines of uplands. It formed in old alluvium deposited over glacial drift. The native vegetation is mainly conifers. Elevation is 100 to 900 feet. The average annual precipitation is 80 to 130 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of moss, twigs, and leaves about 3 inches thick. The surface layer is dark reddish brown silt loam about 10 inches thick. The upper 15 inches of the subsoil is reddish brown silt loam, the next 12 inches is dark brown gravelly silt loam, and the lower part is dark brown gravelly sandy loam about 8 inches thick. Dense glacial drift is at a depth of about 45 inches. Depth to the glacial drift ranges from 40 to 55 inches.

Included in this unit are about 10 percent Le Bar soils, 10 percent Copalis soils, and 15 percent Hoquiam soils that have slopes of less than 30 percent.

Permeability of this Hoquiam soil is moderate to the dense glacial drift and very slow through it. Available water capacity is high. Effective rooting depth is 40 to 55 inches. Runoff is medium, and the hazard of water erosion is moderate. The effect of the drift layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder and western redcedar. On the basis of a 100-year site curve, the mean site index is 170 for Douglas-fir and 159 for western hemlock. On the basis of a 50-year site curve, the mean site index is 127 for Douglas-fir and 113 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 181 cubic feet per acre per year, and for western hemlock at age 50 it is 252 cubic feet per acre per year.

The main limitation for harvesting timber is the steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles are readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, red huckleberry, western swordfern, western brackenfern, and salmonberry.

This map unit is in capability subclass VIe.

48-Humptulips silt loam. This very deep, somewhat excessively drained soil is on flood plains. It formed in alluvium. The slope is 0 to 3 percent. The native vegetation is mainly hardwoods. Elevation is 10 to 50 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 49 degrees F, the average growing season (at 28 degrees) is 180 to 220 days, and the average frost-free season (at 32 degrees) is 150 to 200 days.

Typically, the surface layer is dark grayish brown silt loam about 8 inches thick. The upper 18 inches of the underlying material is dark brown and dark yellowish brown silt loam, and the lower part to a depth of 60 inches or more is dark yellowish brown extremely gravelly sand.

Included in this unit are about 10 percent Grehalem soils, 5 percent Aabab soils, and 5 percent Nuby soils.

Permeability of this Humptulips soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to frequent, very brief periods of flooding in winter.

Most areas of this unit are used for hay or pasture. Some areas are used as woodland.

If this unit is used for hay and pasture, the main limitation is the hazard of flooding. Flooding can be controlled by diking adjacent streams or diverting upland runoff away from the area. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

Red alder is the principal forest species on this unit. Trees of limited extent include western hemlock, bigleaf maple, and black cottonwood. On the basis of a 50-year site curve, the mean site index for red alder is 93. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is 106 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles are, readily available in areas of this unit. Frequent, very brief floods restrict the use of equipment to the dry summer months. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. If seed trees are present, natural reforestation by red alder occurs readily in cutover areas and by western hemlock it occurs periodically. If openings are made in the canopy, invading brushy plants can delay natural reforestation.

Common forest understory species include salmonberry, western swordfern, western brackenfern, red elderberry, and deer fern.

This map unit is in capability subclass IIIw.

49-Ilwaco silt loam, 1 to 8 percent slopes. This very deep, well drained soil is on broad ridgetops, small plateaus, and shoulders. It formed in material derived from sandstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,000 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, moss, and roots about 2 inches thick. The surface layer is dark brown silt loam about 17 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are about 2 percent Lebam soils, 2 percent Montesa soils, and 2 percent Stimson soils. Also included in some mapped areas is as much as 3 percent Ilwaco soils that have slopes of more than 8 percent.

Permeability of this Ilwaco soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland (fig. 17). Some areas are used as rural homesites.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 153, and on the basis of a 50-year site curve, the mean site index is 110. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 243 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, red huckleberry, vine maple, and western swordfern.

This unit is well suited to homesite development.

This map unit is in capability subclass IIIe.

50-Ilwaco silt loam, 8 to 30 percent slopes. This very deep, well drained soil is on back slopes of uplands. It formed in material derived from sandstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,000 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, moss, and roots about 2 inches thick. The surface layer is dark brown silt loam about 15 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are about 10 percent Narel soils, 5 percent Palix and Lebam soils, and 10 percent Ilwaco soils that have slopes of less than 8 percent or more than 30 percent.

Figure 17.-Second growth western hemlock on Ilwaco silt loam, 1 to 8 percent slopes. These soils are in Pacific County.

Permeability of this Ilwaco soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 153, and on the basis of a 50-year site curve, the mean site index is about 110. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 243 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, red huckleberry, vine maple, and western swordfern.

This map unit is in capability subclass IVe.

51-Ilwaco silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on back slopes and foot slopes of uplands. It formed in material derived from sandstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,000 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, moss, and roots about 2 inches thick. The surface layer is dark brown silt loam about 12 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are about 10 percent Narel soils and 5 percent Lebam and Palix soils. Also included in some mapped areas is as much as 5 percent Ilwaco soils that have slopes of less than 30 percent.

Permeability of this Ilwaco soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 153, and on the basis of a 50-year site curve, the mean site index is 110. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 243 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, red huckleberry, vine maple, and western swordfern.

This map unit is in capability subclass VIe.

52-Ilwaco silt loam, cool, 1 to 8 percent slopes. This very deep, well drained soil is on broad ridgetops, small plateaus, and shoulders. It formed in material derived from sandstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,000 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles, twigs, moss, and roots about 2 inches thick. The surface layer is dark brown silt loam about 17 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are about 2 percent Lebam, cool, soils; 2 percent Montesa soils; and 2 percent Stimson soils. Also included in some mapped areas is as much as 3 percent Ilwaco, cool, soils that have slopes of more than 8 percent.

Permeability of this Ilwaco soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used as rural homesites.

Western hemlock and Sitka spruce are the principal forest species on this unit. Trees of limited extent include western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 138, and on the basis of a 50-year site curve, the mean site index is 99. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 214 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made

in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salal, salmonberry, red huckleberry, vine maple, and western swordfern.

This unit is well suited to homesite development.

This map unit is in capability subclass IVe.

53-Ilwaco silt loam, cool, 8 to 30 percent slopes. This very deep, well drained soil is on back slopes of uplands. It formed in material derived from sandstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,000 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles, twigs, moss, and roots about 2 inches thick. The surface layer is dark brown silt loam about 15 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are about 10 percent Narel soils and 5 percent Palix, cool, soils and Lebam, cool, soils. Also included is about 10 percent Ilwaco, cool, soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Ilwaco soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock and Sitka spruce are the principal forest species on this unit. Trees of limited extent include western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 138, and on the basis of a 50-year site curve, the mean site index is 99. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 214 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salal, salmonberry, red huckleberry, vine maple, and western swordfern.

This map unit is in capability subclass IVe.

54-Ilwaco silt loam, cool, 30 to 65 percent slopes. This very deep, well drained soil is on back slopes and foot slopes of uplands. It formed in material derived from sandstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,000 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles, twigs, moss, and roots about 2 inches thick. The surface layer is dark brown silt loam about 12 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silt loam.

Included in this unit are about 10 percent Narel soils and 5 percent Lebam, cool, soils and Palix, cool, soils. Also included in some mapped areas is as much as 5 percent Ilwaco, cool, soils that have slopes of less than 30 percent.

Permeability of this Ilwaco soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock and Sitka spruce are the principal forest species on this unit. Trees of limited extent include western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 138, and on the basis of a 50-year site curve, the mean site index is 99. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 214 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths,

skid trails, and firebreaks are subject to rifling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salal, salmonberry, red huckleberry, vine maple, and western swordfern.

This map unit is in capability subclass VIe.

55-Juno sandy loam. This very deep, somewhat excessively drained soil is on flood plains. It formed in alluvium derived from glacial sediment. The slope is 0 to 3 percent. The native vegetation is mainly conifers. Elevation is 100 to 300 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark grayish brown sandy loam about 12 inches thick. The upper 6 inches of the underlying material is dark grayish brown gravelly sand, and the lower part to a depth of 60 inches or more is dark grayish brown and yellowish brown extremely gravelly sand.

Included in this unit is about 10 percent Humptulips soils. Also included are small areas of soils that are in the 120-inch rainfall zone.

Permeability of this Juno soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to frequent, very brief periods of flooding in winter.

Most areas of this unit are used as woodland. A few areas are used for hay and pasture.

Red alder is the principal forest species on this unit. Trees of limited extent include black cottonwood and bigleaf maple. On the basis of a 50-year site curve, the mean site index for red alder is 106. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is 128 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit. Frequent, very brief floods restrict the use of equipment during winter. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. If seed trees are present, natural reforestation by red alder occurs readily in cutover areas. Frequent, very brief floods reduce root respiration and cause seedling mortality. If openings are made in the canopy, invading brushy plants can delay reforestation by red alder.

Common forest understory species include salmonberry, stinging nettle, buttercup, horsetail, and pig-a-back plant.

If this unit is used for hay and pasture, the main limitations are the hazard of flooding and the low available water capacity. Flooding can be controlled by diking adjacent streams or diverting upland runoff away from the area. Because the soil in this unit is droughty, applications of irrigation water should be light and frequent. Sprinkler irrigation is a suitable method. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This map unit is in capability subclass IVw.

56-Katula very cobbly loam, 5 to 30 percent slopes. This moderately deep, well drained soil is on narrow ridgetops, shoulders, and back slopes of uplands. It formed in colluvium and residuum derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 1,100 to 2,200 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles and twigs about 7 inches thick. The upper 3 inches of the surface layer is dark reddish brown very cobbly loam, and the lower 10 inches is dark reddish brown extremely cobbly loam. The subsoil is dark reddish brown and dark brown extremely cobbly clay loam about 19 inches thick. Fractured basalt is at a depth of about 32 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are about 10 percent Bunker soils, 3 percent Boistfort soils, and 2 percent Lates and Murnen soils. Also included in some mapped areas are as much as 5 percent Katula soils that have slopes of more than 30 percent and 2 percent Rock outcrop.

Permeability of this Katula soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index is 143 for Douglas-fir and 145 for western hemlock. On the

basis of a 50-year site curve, the mean site index is 108 for Douglas-fir and 104 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 149 cubic feet per acre per year, and for western hemlock at age 50 it is 228 cubic feet per acre per year.

The main limitation for harvesting timber is cobbles on the surface, which can hinder ground-skidding harvesting operations. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. This unit is well suited to year-round logging operations. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs periodically. Droughtiness of the surface layer increases seedling mortality, particularly on south- and southwest-facing slopes. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. Seedlings planted in the less fertile subsoil grow poorly and have poor vigor. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. Because the rooting depth is restricted by the underlying fractured bedrock, trees are subject to occasional windthrow.

Common forest understory species include salal, Oregon-grape, red huckleberry, western swordfern, and western brackenfern.

This map unit is in capability subclass VIs.

57-Katula very cobbly loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on narrow ridgetops and back slopes of uplands. It formed in colluvium and residuum derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 1,100 to 2,200 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles and twigs about 7 inches thick. The upper 3 inches of the surface layer is dark reddish brown very cobbly loam, and the lower 10 inches is dark reddish brown extremely cobbly loam. The subsoil is dark reddish brown and dark brown extremely cobbly clay loam about 19 inches thick. Fractured basalt is at a depth of about 32 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are about 10 percent Bunker soils, 3 percent Boistfort soils, and 2 percent Lates and Murnen soils. Also included in some mapped areas are as much as 5 percent Katula soils that have slopes of less than 30 percent or more than 65 percent and 4 percent Rock outcrop.

Permeability of this Katula soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index is 143 for Douglas-fir and 145 for western hemlock. On the basis of a 50-year site curve, the mean site index is 108 for Douglas-fir and 104 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 149 cubic feet per acre per year, and for western hemlock at age 50 it is 228 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs periodically. Droughtiness of the surface layer increases seedling mortality, particularly on south- or southwest-facing slopes. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. Seedlings planted in the less fertile subsoil grow poorly and have poor vigor. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. Because the rooting depth is restricted by the underlying fractured bedrock, trees are subject to occasional windthrow.

Common forest understory species include salal, Oregon-grape, red huckleberry, western swordfern, and western brackenfern.

This map unit is in capability subclass VIs.

58-Katula very cobbly loam, 65 to 90 percent slopes. This moderately deep, well drained soil is on narrow ridgetops and back slopes of uplands. It formed in colluvium and residuum derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 1,100 to 2,200 feet. The average annual precipitation is 70 to 120 inches, the average annual air, temperature is

about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles and twigs about 7 inches thick. The upper 3 inches of the surface layer is dark reddish brown very cobbly loam, and the lower 10 inches is dark reddish brown extremely cobbly loam. The subsoil is dark reddish brown and dark brown extremely cobbly clay loam about 19 inches thick. Fractured basalt is at a depth of about 32 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are about 10 percent Bunker soils, 5 percent Katula soils that have slopes of less than 65 percent, and 5 percent Rock outcrop.

Permeability of this Katula soil is moderate. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index is 143 for Douglas-fir and 145 for western hemlock. On the basis of a 50-year site curve, the mean site index is 108 for Douglas-fir and 104 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 149 cubic feet per acre per year, and for western hemlock at age 50 it is 228 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs periodically. Droughtiness of the surface layer increases seedling mortality, particularly on south- or southwest-facing slopes. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. Seedlings planted in the less fertile subsoil grow poorly and have poor vigor. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. Because the rooting depth is restricted by the underlying fractured bedrock, trees are subject to occasional windthrow.

Common forest understory species include salal, Oregon-grape, red huckleberry, western swordfern, and western brackenfern.

This map unit is in capability subclass VIIs.

59-Knappton silt loam, 8 to 30 percent slopes. This deep, well drained soil is on side slopes of uplands. It formed in colluvium derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The surface layer is dark brown and dark reddish brown silt loam about 12 inches thick. The upper 12 inches of the subsoil is reddish brown gravelly silt loam, and the lower part is dark brown and strong brown gravelly silty clay loam about 19 inches thick. Weathered, fractured basalt is at a depth of about 43 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 10 percent Squally soils, 5 percent Vesta and Traham soils, and 10 percent Knappton soils that have slopes of more than 30 percent. Also included in some mapped areas is as much as 2 percent Lates, Murnen, and Swem soils.

Permeability of this Knappton soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 146, and on the basis of a 50-year site curve, the mean site index is 104. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 230 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 3 to 5 feet. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and

Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, western swordfern, red huckleberry, and red elderberry.

This map unit is in capability subclass IVe.

60-Knappton silt loam, 30 to 65 percent slopes. This deep, well drained soil is on side slopes of uplands. It formed in colluvium derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The surface layer is dark brown and dark reddish brown sift loam about 11 inches thick. The upper 12 inches of the subsoil is reddish brown gravelly silt loam, and the lower part is dark brown and strong brown gravelly silty clay loam about 21 inches thick. Weathered, fractured basalt is at a depth of about 44 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 10 percent Traham soils, 5 percent Vesta and Squally soils, and 10 percent Knappton soils that have slopes of less than 30 percent or more than 65 percent. Also included in some mapped areas is as much as 2 percent Swem soils.

Permeability of this Knappton soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches ormore. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 146, and on the basis of a 50-year site curve, the mean site index is 104. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 230 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable.

Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 3 to 5 feet. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, western swordfern, red huckleberry, and red elderberry.

This map unit is in capability subclass Vle.

61-Knappton silt loam, 65 to 90 percent slopes. This deep, well drained soil is on side slopes of uplands. It formed in colluvium derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The surface layer is dark brown and dark reddish brown silt loam about 10 inches thick. The upper 12 inches of the subsoil is reddish brown gravelly silt loam, and the lower part is dark brown and strong brown gravelly silty clay loam about 18 inches thick. Weathered, fractured basalt is at a depth of about 40 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 15 percent Traham soils, 5 percent Squally soils, and 5 percent Knappton soils that have slopes of less than 65 percent. Also included in some mapped areas are as much as 2 percent Lates soils and as much as 10 percent soils that are less than 40 inches deep to bedrock.

Permeability of this Knappton soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index for western

hemlock is 146, and on the basis of a 50-year site curve, the mean site index is 104. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 230 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 3 to 5 feet. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, western swordfern, red huckleberry, and red elderberry.

This map unit is in capability subclass VIIe.

62-Lates silt loam, 8 to 30 percent slopes. This moderately deep, well drained soil is on mountains. It formed in material derived from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 1,800 to 2,700 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 44 degrees F, and the average growing season (at 28 degrees) is 150 to 180 days.

Typically, the surface layer is very dark brown and black silt loam about 14 inches thick. The subsoil is dark brown gravelly loam about 21 inches thick. Fractured basalt is at a depth of about 35 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are about 10 percent Murnen soils and 5 percent Lates soils that have slopes of more than 30 percent. Also included in some mapped areas are as much as 2 percent soils that are less than 20 inches deep to bedrock, 2 percent poorly drained soils, and 1 percent Rock outcrop.

Permeability of this Lates soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock, Douglas-fir, and Pacific silver fir are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index is 135 for western hemlock and 138 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 95 for western hemlock and 110 for Douglas-fir. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 209 cubic feet per acre per year, and for Douglas-fir at age 70 it is 142 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Occasionally, a snowpack hinders use of ground skidding in harvesting. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir or noble fir seedlings. If seed trees are present, natural reforestation by western hemlock and Pacific silver fir occurs periodically. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can delay establishment of Douglas-fir seedlings and natural regeneration of western hemlock. Because the rooting depth is restricted by the underlying fractured bedrock, trees are subject to occasional windthrow.

Common forest understory species include salmonberry, salal, red huckleberry, western swordfern, and western brackenfern.

This map unit is in capability subclass IVe.

63-Lates silt loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on mountains. It formed in material derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 1,800 to 2,700 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 44 degrees F, and the average growing season (at 28 degrees) is 150 to 180 days.

Typically, the surface layer is very dark brown and black silt loam about 14 inches thick. The subsoil is dark brown gravelly loam about 21 inches thick. Fractured

basalt is at a depth of about 35 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit are about 10 percent Murnen soils and 5 percent Lates soils that have slopes of less than 30 percent or more than 65 percent. Also included in some mapped areas are as much as 2 percent soils that are less than 20 inches deep to bedrock, 1 percent poorly drained soils, and 2 percent Rock outcrop.

Permeability of this Lates soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock, Douglas-fir, and Pacific silver fir are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index is 135 for western hemlock and 138 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 95 for western hemlock and 110 for Douglas-fir. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 209 cubic feet per acre per year, and for Douglas-fir at age 70 it is 142 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Occasionally, a snowpack hinders skidding and yarding. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir or noble fir seedlings. If seed trees are present, natural reforestation by western hemlock and Pacific silver fir occurs periodically. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can delay establishment of Douglas-fir seedlings and natural regeneration of western hemlock. Because the rooting depth is restricted by the underlying fractured bedrock, trees are subject to occasional windthrow.

Common forest understory species include salmonberry, salal, red huckleberry, western swordfern, and western brackenfern.

This map unit is in capability subclass VIe.

64-Lates silt loam, 65 to 90 percent slopes. This moderately deep, well drained soil is on mountains. It formed in material derived from basalt. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is 1,800 to 2,700 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 44 degrees F, and the average growing season (at 28 degrees) is 150 to 180 days.

Typically, the surface layer is very dark brown and black silt loam about 14 inches thick. The subsoil is dark brown gravelly loam about 21 inches thick. Fractured basalt is at a depth of about 35 inches. Depth to bedrock ranges from 20 to 40 inches.

Included in this unit is about 10 percent Lates soils that have slopes of less than 65 percent. Also included in some mapped areas are as much as 5 percent soils that are less than 20 inches deep to bedrock and 2 percent Rock outcrop.

Permeability of this Lates soil is moderate. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland.

Western hemlock, Douglas-fir, and Pacific silver fir are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index is about 135 for western hemlock and about 138 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is about 95 for western hemlock and about 110 for Douglas-fir. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 209 cubic feet per acre per year, and for Douglas-fir at age 70 it is about 142 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Occasionally, a snowpack hinders cable yarding. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir or noble fir seedlings. If seed trees are present, natural reforestation by western hemlock and Pacific silver fir occurs periodically. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on

ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can delay establishment of Douglas-fir seedlings and natural regeneration of western hemlock. Because the rooting depth is restricted by the underlying fractured bedrock, trees are subject to occasional windthrow.

Common forest understory species include salmonberry, salal, red huckleberry, western swordfern, and western brackenfern.

This map unit is in capability subclass VIIe.

65-Lebam silt loam, 1 to 8 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from siltstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 20 to 1,100 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 2 inches thick. The surface layer is dark brown and dark yellowish brown silt loam about 21 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silty clay loam.

Included in this unit are about 5 percent Ilwaco soils and 5 percent Arta soils. Also included in some mapped areas is as much as 10 percent Lebam soils that have slopes of more than 8 percent.

Permeability of this Lebam soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used as rural homesites.

Western hemlock and Douglas-fir are the principal forest species on this unit. Trees of limited extent include red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index is 159 for western hemlock and 173 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 112 for western hemlock and 134 for Douglas-fir. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 252 cubic feet per acre per year, and for Douglas-fir at age 60 it is 184 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, red huckleberry, salmonberry, vine maple, and western swordfern.

This unit is well suited to homesite development. If the unit is used for septic tank absorption fields, the limitation of moderate permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIIe.

66-Lebam silt loam, 8 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from siltstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 20 to 1,100 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 2 inches thick. The surface layer is dark brown and dark yellowish brown silt loam about 18 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silty clay loam.

Included in this unit are about 10 percent Palix soils, 5 percent Ilwaco soils, 2 percent Stimson soils, 2 percent Vesta and Knappton soils, and 1 percent Swem soils. Also included in some mapped areas is as much as 10 percent Lebam soils that have slopes of less than 8 percent.

Permeability of this Lebam soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock and Douglas-fir are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and Sitka spruce. On the basis of a 100-year site curve, the mean site index is 159 for western hemlock and 173 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 112 for western hemlock and 134 for Douglas-fir. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 252 cubic feet per acre per year, and for Douglas-fir at age 60 it is 184 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet,

unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, red huckleberry, salmonberry, vine maple, and western swordfern.

This map unit is in capability subclass IVe.

67-Lebam silt loam, cool, 5 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from siltstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 20 to 600 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles, twigs, and moss about 2 inches thick. The surface layer is dark brown and dark yellowish brown silt loam about 21 inches thick. The subsoil to a depth of 60 inches or more is dark yellowish brown silty clay loam.

Included in this unit are about 5 percent Arta soils; 5 percent Ilwaco, cool, soils; and 10 percent Palix, cool, soils.

Permeability of this Lebam soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is about 140, and on the basis of a 50-year site curve, the mean site index is about 100. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 218 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration by western hemlock and Sitka spruce.

Common forest understory species include salal, red huckleberry, salmonberry, vine maple, and western swordfern.

This map unit is in capability subclass IVe.

68-Le Bar silt loam, 1 to 8 percent slopes. This very deep, well drained soil is on glacial terraces. It formed in old alluvium. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The surface layer is dark brown and dark reddish brown silt loam about 12 inches thick. The subsoil to a depth of 60 inches or more is dark brown and reddish brown silt loam.

Included in this unit are about 10 percent Hoquiam soils and 2 percent Copalis soils. Also included in some mapped areas is as much as 10 percent Le Bar soils that have slopes of more than 8 percent.

Permeability of this Le Bar soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some small areas are used for hay, pasture, or rural homesites.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 176 for Douglas-fir and 164 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 187 cubic feet per acre per year, and for western hemlock at age 50 it is 262 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, western swordfern, Oregon-grape, vine maple, and red huckleberry.

This unit is suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is required on this unit to reduce soil erosion.

This unit is well suited to homesite development. If the unit is used for septic tank absorption fields, the limitation of moderate permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIIe.

69-Le Bar silt loam, 8 to 30 percent slopes. This very deep, well drained soil is on glacial terraces. It formed in old alluvium. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The surface layer is dark brown and dark reddish brown silt loam about 14 inches thick. The subsoil to a depth of 60 inches or more is dark brown and reddish brown silt loam.

Included in this unit are about 10 percent Hoquiam soils and 2 percent Copalis soils. Also included in some mapped areas is as much as 15 percent Le Bar soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Le Bar soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 176 for Douglas-fir and 164 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 187 cubic feet per acre per year, and for western hemlock at age 50 it is 262 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, western swordfern, Oregon-grape, vine maple, and red huckleberry.

This map unit is in capability subclass IVe.

70-Le Bar silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on glacial terraces. It formed in old alluvium. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The surface layer is dark brown and dark reddish brown silt loam about 10 inches thick. The subsoil to a depth of 60 inches or more is dark brown and reddish brown silt loam.

Included in this unit are about 10 percent Copalis soils and 10 percent Hoquiam soils. Also included in some mapped areas is as much as 5 percent Le Bar soils that have slopes of less than 30 percent.

Permeability of this Le Bar soil is moderate. Available water capacity is high. Effective rooting depth is 60

inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 176 for Douglas-fir and 164 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 117 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 187 cubic feet per acre per year, and for western hemlock at age 50 it is 262 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, western swordfern, Oregon-grape, vine maple, and red huckleberry.

This map unit is in capability subclass VIe.

71-Lyre very gravelly loamy sand, 0 to 8 percent slopes. This very deep, somewhat excessively drained soil is on glacial outwash plains. It formed in glacial outwash. The native vegetation is mainly conifers. Elevation is 50 to 300 feet. The average annual precipitation is 60 to 90 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, twigs, and leaves about 3 inches thick. The surface layer is dark reddish brown very gravelly loamy sand about 7 inches thick. The upper 16 inches of the subsoil is dark reddish brown very gravelly sandy loam, and the lower 12 inches is dark brown very gravelly sand. The substratum to a depth of 60 inches or more is dark grayish brown extremely gravelly sand.

Included in this unit are about 10 percent Carstairs soils, 5 percent Lyre Variant soils, and 5 percent Spanaway soils.

Permeability of this Lyre soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland, pasture, and homesites. It is also used for hay and as a source of Christmas trees.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include western hemlock, western redcedar, bigleaf maple, and red alder. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 157, and on the basis of a 50-year site curve, the mean site index is 119. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 167 cubic feet per acre per year.

This unit is well suited to year-round logging operations. Using wheeled or tracked equipment when the soil is wet can cause ruts and damage to tree roots. When wet, unsurfaced roads and skid trails are slippery. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by Douglas-fir occurs infrequently. Droughtiness of the surface layer increases seedling mortality. Seedlings planted in the less fertile subsoil grow poorly and have poor vigor. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include salal, salmonberry, red huckleberry, western brackenfern, and western swordfern.

Scotch pine and Douglas-fir can be harvested for use as Christmas trees.

This unit is poorly suited to hay and pasture. It is limited mainly by the low available water capacity and low soil fertility. Because the soil in this unit is droughty, applications of irrigation water should be light and frequent. Sprinkler irrigation is a suitable method. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is well suited to homesite development. Removal of pebbles and cobbles in disturbed areas is needed for best results in landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IVe.

72-Lyre Variant very gravelly sandy loam. This moderately deep, moderately well drained soil is on benches and valley floors. It formed in glacial till and outwash. The slope is 0 to 3 percent. The native vegetation is mainly conifers. Elevation is 100 to 300 feet. The average annual precipitation is 60 to 75 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is dark brown very gravelly sandy loam about 9 inches thick. The subsoil is dark reddish brown and dark brown very gravelly sandy loam about 19 inches thick. Dense glacial drift is at a depth of about 28 inches. Depth to the glacial drift ranges from 20 to 40 inches.

Included in this unit are about 10 percent Lyre soils, 5 percent Carstairs soils, and 5 percent Spanaway soils.

Permeability of this Lyre Variant soil is rapid to the dense glacial drift and very slow through it. Available water capacity is low. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the glacial drift in winter and spring. The effect of the drift layer on use and management is similar to the effect of a hardpan.

Most areas of this unit are used as rural homesites and for hay and pasture. Some areas are used as woodland.

This unit is well suited to hay and pasture. The main limitations are low soil fertility and restricted rooting depth. The perched water table, which builds up over the glacial drift during the rainy period in winter and spring, generally limits the suitability of this unit for deep-rooted crops. The dense glacial drift also reduces the yield of deep-rooted plants. Where feasible, deep ripping of the glacial drift helps to overcome this limitation.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 172, and on the basis of a 50-year site curve, the mean site index is 132. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 183 cubic feet per acre per year.

This unit is well suited to year-round logging operations. Using wheeled or tracked equipment when the soil is wet can cause ruts and damage to tree roots. When wet, unsurfaced roads and skid trails are slippery and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. Droughtiness of the surface layer increases seedling mortality. Seedlings planted in the less fertile subsoil grow poorly and have poor vigor. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings. Because of the seasonal perched water table, trees are occasionally subject to windthrow.

Common forest understory species include vine maple, western brackenfern, western swordfern, red huckleberry, and Oregon-grape.

If this unit is used for homesite development, the main limitations are depth to the dense glacial drift and depth to the perched water table. Drainage should be provided for buildings with basements and crawl spaces. Excavation for building sites is limited by the dense glacial drift. Because of this restrictive layer, onsite sewage disposal systems often fail or do not function properly. Plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes. Removal of pebbles and cobbles in disturbed areas is needed for the best results in landscaping, particularly in areas used for lawns.

This map unit is in capability subclass IVw.

73-Lytell silt loam, 8 to 30 percent slopes. This deep, well drained soil is on slumps of uplands. It formed in colluvium derived from siltstone or in fine-grained sandstone sediment. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 20 to 1,500 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of twigs and needles about 3 inches thick. The upper 10 inches of the surface layer is dark brown silt loam, and the lower 6 inches is dark brown silty clay loam. The subsoil is dark yellowish brown silty clay loam about 34 inches thick. Partly consolidated siltstone is at a depth of about 50 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 5 percent Astoria and Zenker soils, 1 percent Boistfort and Bunker soils, 2 percent Stimson soils, and 2 percent Swern soils. Also included in some mapped areas are as much as 5 percent Lytell soils that have slopes of more than 30 percent and 2 percent basalt Rock outcrop.

Permeability of this Lytell soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to slippage.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, Sitka spruce, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 181 for Douglas-fir and 173 for western hemlock. On the basis of a 50-year site curve, the mean site index is 136 for Douglas-fir and 123 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 192 cubic feet per acre per year, and for western hemlock at age 50 it is 279 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, red huckleberry, western swordfern, vine maple, and western brackenfern.

This map unit is in capability subclass IVe.

74-Lytell silt loam, 30 to 65 percent slopes. This deep, well drained soil is on slumps of uplands. It formed in colluvium derived from siltstone or in fine-grained sandstone sediment. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is 20 to 1,500 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of twigs and needles about 3 inches thick. The upper 11 inches of the surface layer is dark brown silt loam, and the lower 6 inches is dark brown silty clay loam. The subsoil is dark yellowish brown silty clay loam about 33 inches thick. Partly consolidated siltstone is at a depth of about 50 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 5 percent Zenker soils, 2 percent Astoria soils, 2 percent Swem soils, and 1 percent Stimson soils. Also included in some mapped areas are as much as 5 percent Lytell soils that have slopes of less than 30 percent or more than 65 percent and as much as 10 percent soils that are less than 40 inches deep to bedrock.

Permeability of this Lytell soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. This soil is subject to slippage.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, Sitka spruce, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 174 for Douglas-fir and 173 for western hemlock. On the basis of a 50-year site curve, the mean site index is 132 for Douglas-fir and 123 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 185 cubic feet per acre per year, and for western hemlock at age 50 it is 279 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, red huckleberry, vine maple, and western brackenfern.

This map unit is in capability subclass VIe.

75-Lytell silt loam, 65 to 90 percent slopes. This deep, well drained soil is on slumps of uplands. It formed in colluvium derived from siltstone or in fine-grained sandstone sediment. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is 20 to 1,500 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the

average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of twigs and needles about 3 inches thick. The upper 12 inches of the surface layer is dark brown silt loam, and the lower 6 inches is dark brown silty clay loam. The subsoil is dark yellowish brown silty clay loam about 32 inches thick. Partly consolidated siltstone is at a depth of about 50 inches. Depth to bedrock ranges from 40 to 60 inches or more.

Included in this unit is about 5 percent Zenker soils. Also included in some mapped areas are as much as 10 percent Lytell soils that have slopes of less than 65 percent, 2 percent basalt Rock outcrop, and 10 percent soils that are less than 40 inches deep to bedrock.

Permeability of this Lytell soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe. This soil is subject to slippage.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, Sitka spruce, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 175 for Douglas-fir and 173 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 123 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 186 cubic feet per acre per year, and for western hemlock at age 50 it is 279 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, red huckleberry, vine maple, and western brackenfern.

This map unit is in capability subclass VIIe.

76-Melbourne silt loam, 1 to 8 percent slopes. This very deep, well drained soil is on uplands. It formed in residuum derived from siltstone and sandstone. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 250 to 700 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, moss, and bark about 1 inch thick. The surface layer is very dark grayish brown silt loam about 14 inches thick. The upper 5 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is dark brown and dark yellowish brown silty clay.

Included in this unit are about 5 percent Buckpeak soils, 5 percent Centralia soils, and 5 percent Melbourne soils that have slopes of more than 8 percent.

Permeability of this Melbourne soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used as rural homesites.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 175 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 132 for Douglas-fir and 98 for red alder. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 186 cubic feet per acre per year, and for red alder at age 40 it is 115 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include salal, red huckleberry, Oregon-grape, western brackenfern, and western swordfern.

If this unit is used for homesite development, the main limitations are the shrink-swell potential and the

moderately slow permeability. The effects of shrinking and swelling can be minimized by using a proper engineering design and by backfilling with material that has low shrink-swell potential. Septic tank absorption fields do not function properly because of the moderately slow permeability.

This map unit is in capability subclass IIe.

77-Melbourne silt loam, 8 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in residuum derived from siltstone and sandstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 250 to 700 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, moss, and bark about 1 inch thick. The surface layer is very dark grayish brown silt loam about 10 inches thick. The upper 9 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is dark brown and dark yellowish brown silty clay.

Included in this unit are about 10 percent Centralia soils, 5 percent Buckpeak soils, and 10 percent Melbourne soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Melbourne soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 175 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 132 for Douglas-fir and 98 for red alder. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 186 cubic feet per acre per year, and for red alder at age 40 it is 115 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include salal, red huckleberry, Oregon-grape, western brackenfern, and western swordfern.

This map unit is in capability subclass IVe.

78-Melbourne silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on uplands. It formed in residuum derived from siltstone and sandstone. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is 250 to 700 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, moss, and bark about 1 inch thick. The surface layer is very dark grayish brown silt loam about 12 inches thick. The upper 7 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is dark brown and dark yellowish brown silty clay.

Included in this unit are about 15 percent Centralia soils, 10 percent Buckpeak soils, and 10 percent Melbourne soils that have slopes of less than 30 percent.

Permeability of this Melbourne soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, western hemlock, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 175 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 132 for Douglas-fir and 98 for red alder. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 186 cubic feet per acre per year, and for red alder at age 40 it is 115 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rifling and

gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include salal, red huckleberry, Oregon-grape, western brackenfern, and western swordfern.

This map unit is in capability subclass VIe.

79-Montesa silt loam, 1 to 8 percent slopes. This very deep, somewhat poorly drained soil is on alluvial fans. It formed in alluvium derived from sedimentary and igneous sediment. The native vegetation is mainly conifers. Elevation is 25 to 300 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is dark brown silt loam about 18 inches thick. The subsoil is strong brown fine sandy loam about 7 inches thick. The substratum to a depth of 60 inches or more is pale brown silt loam.

Included in this unit are about 10 percent Satsop soils and 10 percent Skamo soils.

Permeability of this Montesa soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The seasonal high water table is at a depth of 18 to 30 inches from October through April.

Most areas of this unit are used as woodland. Some areas are used for hay, pasture, or rural homesites.

Red alder is the principal forest species on this unit. Trees of limited extent include Douglas-fir, western hemlock, bigleaf maple, and western redcedar. On the basis of a 50-year site curve, the mean site index for red alder is 102. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is 121 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir and western hemlock seedlings. If seed trees are present, natural reforestation by red alder occurs readily. The seasonal high water table reduces root respiration and increases seedling mortality. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings. This unit is subject to occasional windthrow because of the seasonal high water table.

Common forest understory species include salmonberry, red huckleberry, western swordfern, Oregon-grape, and western brackenfern.

This unit is well suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

If this unit is used for homesite development, the main limitations are the seasonal high water table and moderately slow permeability. Septic tank absorption fields do not function properly because of wetness and the moderately slow permeability. The water table can be lowered by installing tile drains if adequate outlets are available.

This map unit is in capability subclass IIIw.

80-Mopang silt loam, 5 to 30 percent slopes. This deep, well drained soil is on ground moraines of uplands. It formed in old alluvium deposited over glacial drift. The native vegetation is mainly conifers. Elevation is 100 to 400 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 4 inches thick. The surface layer is dark reddish brown silt loam about 6 inches thick. The subsoil is dark reddish brown and dark brown silty clay loam about 37 inches thick. The substratum is strong brown very gravelly silt loam about 8 inches thick. Dense glacial drift is at a depth of about 51 inches. Depth to the glacial drift ranges from 40 to 60 inches or more.

Included in this unit are about 10 percent Calawah soils, 5 percent Papac soils, and 10 percent Mopang soils that have slopes of more than 30 percent.

Permeability of this Mopang soil is moderate to the dense glacial drift and very slow through it. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The effect of the drift layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include western redcedar, Sitka spruce, red alder, and Douglas-fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 157, and on the basis of a 50-year site curve, the mean site index is 111. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 249 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles are readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, red huckleberry, western swordfern, western brackenfern, and salmonberry.

This map unit is in capability subclass IVe.

81-Mopang silt loam, 30 to 65 percent slopes. This deep, well drained soil is on ground moraines of uplands. It formed in old alluvium deposited over glacial drift. The native vegetation is mainly conifers. Elevation is 100 to 400 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 4 inches thick. The surface layer is dark reddish brown silt loam about 6 inches thick. The subsoil is dark reddish brown and dark brown silty clay loam about 40 inches thick. The substratum is strong brown very gravelly silt loam about 8 inches thick. Dense glacial drift is at a depth of about 54 inches. Depth to the glacial drift ranges from 40 to 60 inches or more.

Included in this unit are about 10 percent Calawah soils, 10 percent Papac soils, and 15 percent Mopang soils that have slopes of less than 30 percent or more than 65 percent.

Permeability of this Mopang soil is moderate to the dense glacial drift and very slow through it. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The effect of the drift layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include western redcedar, Sitka spruce, red alder, and Douglas-fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 147, and on the basis of a 50-year site curve, the mean site index is 105. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 232 cubic feet per acre per year.

The main limitation for harvesting timber is the steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles are readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, red huckleberry, western swordfern, western brackenfern, and salmonberry.

This map unit is in capability subclass VIe.

82-Mopang silt loam, 65 to 90 percent slopes. This deep, well drained soil is on ground moraines of uplands. It formed in old alluvium deposited over glacial drift. The native vegetation is mainly conifers. Elevation is 100 to 400 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 4 inches thick. The surface layer is dark reddish brown silt loam about 5 inches thick. The subsoil is dark reddish brown and dark brown silty clay loam about 43 inches thick. The substratum is strong brown very gravelly silt loam about 9 inches thick. Dense glacial drift is at a depth of about 57 inches. Depth to the glacial drift ranges from 40 to 60 inches or more.

Included in this unit are about 15 percent Papac soils and 15 percent Mopang soils that have slopes of less than 65 percent.

Permeability of this Mopang soil is moderate to the dense glacial drift and very slow through it. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water

erosion is severe. The effect of the drift layer on use and management is similar to the effect of a hardpan. This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is about 147, and on the basis of a 50-year site curve, the mean site index is about 105. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 232 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles are readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, firebreaks, and roadfills are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, red huckleberry, western swordfern, western brackenfern, and salmonberry.

This map unit is in capability subclass VIIe.

83-Mopang silt loam, cool, 5 to 30 percent slopes. This deep, well drained soil is on ground moraines of uplands. It formed in old alluvium deposited over glacial drift. The native vegetation is mainly conifers. Elevation is sea level to 200 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles, twigs, and moss about 4 inches thick. The surface layer is dark reddish brown silt loam about 6 inches thick. The subsoil is dark reddish brown and dark brown silty clay loam about 37 inches thick. The substratum is strong brown very gravelly silt loam about 8 inches thick. Dense glacial drift is at a depth of about 51 inches. Depth to the glacial drift ranges from 40 to 60 inches or more.

Included in this unit are about 10 percent Calawah, cool, soils; 5 percent Papac soils; and 5 percent Mopang, cool, soils that have slopes of more than 30 percent.

Permeability of this Mopang soil is moderate to the dense glacial drift and very slow through it. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The effect of the drift layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is about 138, and on the basis of a 50-year site curve, the mean site index is about 98. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 214 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles are readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salal, red huckleberry, western swordfern, western brackenfern, and salmonberry.

This map unit is in capability subclass IVe.

84-Mopang silt loam, cool, 30 to 65 percent slopes. This deep, well drained soil is on ground moraines of uplands. It formed in old alluvium deposited over glacial drift. The native vegetation is mainly conifers. Elevation is sea level to 200 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles, twigs, and moss about 4 inches thick. The surface layer is dark reddish brown silt loam about 6

inches thick. The subsoil is dark reddish brown and dark brown silty clay loam about 40 inches thick. The substratum is strong brown very gravelly silt loam about 8 inches thick. Dense glacial drift is at a depth of about 54 inches. Depth to the glacial drift ranges from 40 to 60 inches or more.

Included in this unit are about 10 percent Calawah, cool, soils; 5 percent Papac soils; and 10 percent Mopang, cool, soils that have slopes of less than 30 percent or more than 65 percent.

Permeability of this Mopang soil is moderate to the dense glacial drift and very slow through it. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. The effect of the drift layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is about 138, and on the basis of a 50-year site curve, the mean site index is about 98. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 214 cubic feet per acre per year.

The main limitation for harvesting timber is the steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles are readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salal, red huckleberry, western swordfern, western brackenfern, and salmonberry.

This map unit is in capability subclass VIe.

85-Mopang silt loam, cool, 65 to 90 percent slopes. This deep, well drained soil is on ground moraines of uplands. It formed in old alluvium deposited over glacial drift. The native vegetation is mainly conifers. Elevation is sea level to 200 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles, twigs, and moss about 4 inches thick. The surface layer is dark reddish brown silt loam about 5 inches thick. The subsoil is dark reddish brown and dark brown silty clay loam about 43 inches thick. The substratum is strong brown very gravelly silt loam about 9 inches thick. Dense glacial drift is at a depth of about 57 inches. Depth to the glacial drift ranges from 40 to 60 inches or more.

Included in this unit are about 15 percent Papac soils and 15 percent Mopang, cool, soils that have slopes of less than 65 percent.

Permeability of this Mopang soil is moderate to the dense glacial drift and very slow through it. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe. The effect of the drift layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is about 138, and on the basis of a 50-year site curve, the mean site index is about 98. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 214 cubic feet per acre per year.

The main limitation for harvesting timber is the steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles are readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, firebreaks, and roadfills are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent

establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salal, red huckleberry, western swordfern, western brackenfern, and salmonberry.

This map unit is in capability subclass VIIe.

86-Murnen silt loam, 5 to 30 percent slopes. This very deep, well drained soil is on mountains. It formed in material derived from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 1,800 to 2,700 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 44 degrees F, and the average growing season (at 28 degrees) is 150 to 180 days.

Typically, the surface is covered with a mat of leaf litter about 1 inch thick. The upper 8 inches of the surface layer is dark reddish brown silt loam, and the lower 8 inches is dark brown silt loam. The subsoil to a depth of 60 inches or more is dark yellowish brown and yellowish brown silt loam.

Included in this unit are about 10 percent Lates soils and 2 percent Katula soils. Also included in some mapped areas is as much as 10 percent Murnen soils that have slopes of more than 30 percent.

Permeability of this Murnen soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock, Douglas-fir, and Pacific silver fir are the principal forest species on this unit. Trees of limited extent include red alder and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 131 for western hemlock and 136 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 93 for western hemlock and 109 for Douglas-fir. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 202 cubic feet per acre per year, and for Douglas-fir at age 70 it is 139 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet. Occasionally, a snowpack hinders the use of ground skidding in harvesting. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir or noble fir seedlings. If seed trees are present, natural reforestation by western hemlock and Pacific silver fir occurs periodically. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can delay establishment of Douglas-fir seedlings.

Common forest understory species include red huckleberry, salmonberry, western brackenfern, western swordfern, and vine maple.

This map unit is in capability subclass IVe.

87-Murnen silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on mountains. It formed in material derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 1,800 to 2,700 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 44 degrees F, and the average growing season (at 28 degrees) is 150 to 180 days.

Typically, the surface is covered with a mat of leaf litter about 1 inch thick. The upper 5 inches of the surface layer is dark reddish brown silt loam, and the lower 8 inches is dark brown silt loam. The subsoil to a depth of 60 inches or more is dark yellowish brown and yellowish brown silt loam.

Included in this unit are about 10 percent Lates soils and 2 percent Katula soils. Also included in some mapped areas is as much as 5 percent Murnen soils that have slopes of less than 30 percent.

Permeability of this Murnen soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock, Douglas-fir, and Pacific silver fir are the principal forest species on this- unit. Trees of limited extent include red alder and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 131 for western hemlock and 136 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 93 for western hemlock and 109 for Douglas-fir. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 202 cubic feet per acre per year, and for Douglas-fir at age 70 it is 139 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet.

Occasionally, a snowpack hinders the use of ground skidding in harvesting. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir or noble fir seedlings. If seed trees are present, natural reforestation by western hemlock and Pacific silver fir occurs periodically. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can delay establishment of Douglas-fir seedlings.

Common forest understory species include red huckleberry, salmonberry, western brackenfern, western swordfern, and vine maple.

This map unit is in capability subclass VIe.

88-Narel silt loam, 8 to 30 percent slopes. This deep, well drained soil is on foot slopes and shoulders of uplands. It formed in colluvium derived from sandstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,100 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, moss, and twigs about 5 inches thick. The surface layer is very dark brown and dark brown silt loam about 16 inches thick. The subsoil is dark brown and dark yellowish brown silt loam about 41 inches thick. Partly consolidated sandstone is at a depth of about 57 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 10 percent Ilwaco soils, 5 percent Lebam and Palix soils, and 2 percent Willapa soils. Also included in some mapped areas is as much as 10 percent Narel soils that have slopes of more than 30 percent.

Permeability of this Narel soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is about 147, and on the basis of a 50-year site curve, the mean site index is about 104. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 232 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, western swordfern, salmonberry, western brackenfern, and red huckleberry.

This map unit is in capability subclass IVe.

89-Narel silt loam, 30 to 65 percent slopes. This deep, well drained soil is on back slopes of uplands. It formed in colluvium derived from sandstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,100 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, moss, and twigs about 5 inches thick. The surface layer is very dark brown and dark brown silt loam about 18 inches thick. The subsoil is dark brown and dark yellowish brown silt loam about 38 inches thick. Partly consolidated sandstone is at a depth of about 56 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 10 percent Ilwaco soils, 5 percent Lebam and Palix soils, and 2 percent Willapa soils. Also included in some mapped areas is as much as 10 percent Narel soils that have slopes of less than 30 percent or more than 65 percent.

Permeability of this Narel soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is about

147, and on the basis of a 50-year site curve, the mean site index is about 104. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 232 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, western swordfern, salmonberry, western brackenfern, and red huckleberry.

This map unit is in capability subclass VIe.

90-Narel silt loam, 65 to 90 percent slopes. This deep, well drained soil is on back slopes of uplands. It formed in colluvium derived from sandstone. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,100 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, moss, and twigs about 5 inches thick. The surface layer is very dark brown and dark brown silt loam about 11 inches thick. The subsoil is dark brown and dark yellowish brown silt loam about 35 inches thick. Partly consolidated sandstone is at a depth of about 46 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more.

Included in this unit is about 5 percent Palix soils. Also included in some mapped areas is as much as 10 percent Narel soils that have slopes of less than 65 percent.

Permeability of this Narel soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is about 147, and on the basis of a 50-year site curve, the mean site index is about 104. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 232 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, western swordfern, salmonberry, western brackenfern, and red huckleberry.

This map unit is in capability subclass VIIe.

91-Nemah silty clay loam. This very deep, poorly drained soil is in depressional areas of terraces. It formed in alluvium derived from mixed sediment. The slope is 0 to 2 percent. The native vegetation is mainly sedges, rushes, and hardwoods. Elevation is 20 to 400 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of moss, leaves, and twigs about 4 inches thick. The upper 5 inches of the surface layer is black silty clay loam, and the lower 3 inches is mottled, very dark brown silty clay. The subsoil is mottled, dark grayish brown and gray clay about 28 inches thick. The substratum to a depth of 60 inches or more is mottled, gray very gravelly clay.

Included in this unit is about 10 percent Salzer and Wishkah soils. Also included in some mapped areas is as much as 10 percent Nemah soils that are drained.

Permeability of this Nemah soil is very slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that ranges from a depth of 6 inches to above the surface from October through April. Runoff is slow or ponded, and the hazard of water erosion is slight.

This unit is used as woodland.

Red alder is the principal forest species on this unit. Trees of limited extent include western redcedar, Sitka spruce, and western hemlock. On the basis of a 50-year site curve, the mean site index is 86 for red alder. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is 94 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. The seasonal high water table restricts the use of equipment to the dry summer months. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western redcedar seedlings. If seed trees are present, natural reforestation by red alder occurs readily. The seasonal high water table and ponding reduce root respiration and seedling survival. If openings are made in the canopy, invading brushy plants can delay establishment of planted western redcedar seedlings. The restricted rooting depth, caused by the high water table, frequently causes windthrow.

Common forest understory species include devilsclub, salmonberry, sedges, western swordfern, and red elderberry.

This map unit is in capability subclass VIw.

92-Netarts fine sand, 3 to 12 percent slopes. This very deep, well drained soil is on old stabilized sand dunes. It formed in slightly weathered sand. The native vegetation is mainly conifers. Elevation is 20 to 100 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of twigs, bark, and needles about 3 inches thick. The surface layer is dark brown and dark grayish brown fine sand about 3 inches thick. The subsoil is dark brown and grayish brown fine sand about 22 inches thick. The substratum to a depth of 60 inches or more is light brownish gray fine sand. Iron staining is common in the upper part of the subsoil.

Included in this unit are about 5 percent Westport soils, 2 percent Yaquina soils, and 1 percent Orcas and Seastrand soils.

Permeability of this Netarts soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is very severe.

Most areas of this unit are used as woodland. A few areas are irrigated and are used for ornamental azaleas and rhododendrons. Some areas are used as rural homesites.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, shore pine, and Douglas-fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 151, and on the basis of a 50-year site curve, the mean site index is 107. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 240 cubic feet per acre per year.

This unit is suited to year-round harvesting operations. Unsurfaced roads and skid trails are soft. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. The surface layer is loose when dry and hinders the use of wheeled equipment. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs periodically. Droughtiness of the surface layer increases seedling mortality. Seedlings planted in the less fertile subsoil grow poorly and have poor vigor. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. Looseness of the surface layer and subsoil occasionally causes windthrow.

Common forest understory species include evergreen huckleberry, western swordfern, western brackenfern, salal, and salmonberry.

If this unit is used for ornamental crops, the main limitation is low available water capacity. Because this soil is droughty, applications of irrigation water should be light and frequent. Sprinkler irrigation is a suitable method. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is well suited to homesite development. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of

water supplies as a result of seepage from onsite sewage disposal systems. This map unit is in capability subclass IVe.

93-Newberg silt loam. This very deep, well drained soil is on natural levees of flood plains. It formed in alluvium. The slope is 0 to 3 percent. The native vegetation is mainly conifers. Elevation is 50 to 200 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 51 degrees F, the average growing season (at 28 degrees) is 200 to 220 days, and the average frost-free season (at 32 degrees) is 150 to 210 days.

Typically, the surface layer is dark brown silt loam about 13 inches thick. The upper 23 inches of the underlying material is dark yellowish brown sandy loam, and the lower part to a depth of 60 inches or more is dark yellowish brown loamy fine sand.

Included in this unit are about 10 percent Chehalis soils, 10 percent Cloquato soils, and 5 percent Rennie and Salzer soils.

Permeability of this Newberg soil is moderately rapid. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional, brief periods of flooding in winter.

Most areas of this unit are used for cultivated crops and for hay and pasture. Some areas are used as woodland and rural homesites.

This unit is well suited to hay, pasture, and cultivated crops. The main limitation is the hazard of flooding. Flooding can be controlled by diking the adjacent streams or diverting upland runoff away from the area. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

Sweet corn, corn silage, and peas are commonly grown on this unit. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Returning all crop residue to the soil and growing green manure crops help to maintain fertility and tilth.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, black cottonwood, western redcedar, and Oregon ash. On the basis of a 100-year site curve, the mean site index for Douglas-fir is about 160, and on the basis of a 50-year site curve, the mean site index is about 120. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 170 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable.

Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas generally is accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. Occasional, brief floods reduce root respiration and cause seedling mortality. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include willow, vine maple, western brackenfern, Oregon-grape, and trailing blackberry.

If this unit is used for homesite development, the main limitation is the hazard of flooding. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. During periods of flooding, effluent from septic tank absorption fields can surface and create a hazard to health. Roads and streets should be located above the expected flood level.

This map unit is in capability subclass IIw.

94-Newskah loam, 1 to 8 percent slopes. This very deep, well drained soil is on broad ridgetops of terraces. It formed in sandy marine sediment. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 500 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of moss, needles, and twigs about 3 inches thick. The surface layer is very dark grayish brown loam about 20 inches thick. The subsoil is dark yellowish brown loam about 35 inches thick. The substratum to a depth of 60 inches or more is yellowish brown loamy fine sand.

Included in this unit is about 5 percent Ilwaco, cool, soils and Lebam, cool, soils. Also included in some mapped areas are as much as 5 percent Willapa, cool, soils and 10 percent Newskah soils that have slopes of more than 8 percent.

Permeability of this Newskah soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used for hay, pasture, or rural homesites.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 147, and on the basis of a 50-year site curve, the mean site index is 105. Yield tables indicate that the mean annual increment at culmination

(CMAI) for western hemlock at age 50 is 232 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. Seedling mortality is higher in areas of this unit on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salmonberry, red huckleberry, western swordfern, evergreen huckleberry, and salal.

This unit is well suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is required on this unit to reduce soil erosion.

This unit is well suited to homesite development. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IIIe.

95-Newskah loam, 8 to 30 percent slopes. This very deep, well drained soil is on terraces and back slopes of terraces. It formed in sandy marine sediment. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 500 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of moss, needles, and twigs about 3 inches thick. The surface layer is very dark grayish brown loam about 17 inches thick. The subsoil is dark yellowish brown loam about 29 inches thick. The substratum to a depth of 60 inches or more is yellowish brown loamy fine sand.

Included in this unit is about 5 percent Ilwaco, cool, soils; Lebam, cool, soils; and Palix, cool, soils. Also included in some mapped areas are as much as 5 percent Willapa, cool, soils and 10 percent Newskah soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Newskah soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used for hay and pasture.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 147, and on the basis of a 50-year site curve, the mean site index is 105. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 232 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salmonberry, red huckleberry, western swordfern, evergreen huckleberry, and salal.

If this unit is used for hay or pasture, the main limitation is steepness of slope. If practical, seedbed preparation should be on the contour or across the slope. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is required on this unit to reduce soil erosion.

This map unit is in capability subclass IVe.

96-Newskah loam, 30 to 65 percent slopes. This very deep, well drained soil is on back slopes of terraces. It formed in sandy marine sediment. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 500 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about

48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of moss, needles, and twigs about 3 inches thick. The surface layer is very dark grayish brown loam about 13 inches thick. The subsoil is dark yellowish brown loam about 30 inches thick. The substratum to a depth of 60 inches or more is yellowish brown loamy fine sand.

Included in this unit is about 5 percent Ilwaco, cool, soils; Lebam, cool, soils; Narel soils; and Palix, cool, soils. Also included in some mapped areas are as much as 5 percent Willapa, cool, soils and 10 percent Newskah soils that have slopes of less than 30 percent or more than 65 percent.

Permeability of this Newskah soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 147, and on the basis of a 50-year site curve, the mean site index is 105. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 232 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, firebreaks, and logging road drainage ditches are subject to rifling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salmonberry, red huckleberry, western swordfern, evergreen huckleberry, and salal.

This map unit is in capability subclass VIe.

97-Newskah loam, 65 to 90 percent slopes. This very deep, well drained soil is on back slopes of terraces. It formed in sandy marine sediment. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 500 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of moss, needles, and twigs about 3 inches thick. The surface layer is very dark grayish brown loam about 12 inches thick. The subsoil is dark yellowish brown loam about 25 inches thick. The substratum to a depth of 60 inches or more is yellowish brown loamy fine sand.

Included in this unit are about 2 percent Ilwaco, cool, soils and Lebam, cool, soils and 5 percent Narel soils and Palix, cool, soils. Also included in some mapped areas are as much as 2 percent Willapa, cool, soils and 10 percent Newskah soils that have slopes of less than 65 percent.

Permeability of this Newskah soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 147, and on the basis of a 50-year site curve, the mean site index is 105. Yield tables indicate that the mean annual increment at culmination (CMA1) for western hemlock at age 50 is 232 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, firebreaks, and logging road drainage ditches are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salmonberry, red huckleberry, western swordfern, evergreen huckleberry, and salal.

This map unit is in capability subclass VIIe.

98-Nordby very gravelly loam, 1 to 8 percent slopes. This very deep, somewhat excessively drained soil is on benches and terraces. It formed in valley and continental glacial outwash. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 300 to 900 feet. The average annual precipitation is 80 to 130 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaf litter about 3 inches thick. The surface layer is dark reddish brown very gravelly loam about 13 inches thick. The subsoil is dark brown extremely gravelly sandy loam about 20 inches thick. The upper 17 inches of the substratum is dark brown extremely gravelly loamy sand, and the lower part to a depth of 60 inches or more is dark yellowish brown extremely gravelly sand.

Included in this unit are about 10 percent O'Brien and Willaby soils, 5 percent Copalis and Hoquiam soils, and 2 percent Carstairs and Lyre soils. Also included in some mapped areas is as much as 10 percent Nordby soils that have slopes of more than 8 percent.

Permeability of this Nordby soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more, but there are few roots below a depth of 30 inches. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used as rural homesites.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 172 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 129 for Douglas-fir and 119 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 183 cubic feet per acre per year, and for western hemlock at age 50 it is 266 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are slippery. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit. This unit is well suited to year-round logging operations except during the short periods when the soil is wet. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. Droughtiness of the surface layer increases seedling mortality. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, vine maple, western brackenfern, and western swordfern.

This unit is well suited to homesite development. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IVe.

99-Nordby very gravelly loam, 8 to 30 percent slopes. This very deep, somewhat excessively drained soil is on benches and terraces. It formed in valley and continental glacial outwash. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 300 to 900 feet. The average annual precipitation is 80 to 130 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaf litter about 3 inches thick. The surface layer is dark reddish brown very gravelly loam about 15 inches thick. The subsoil is dark brown extremely gravelly sandy loam about 18 inches thick. The upper 19 inches of the substratum is dark brown extremely gravelly loamy sand, and the lower part to a depth of 60 inches or more is dark yellowish brown extremely gravelly sand.

Included in this unit are about 5 percent O'Brien and Willaby soils and 10 percent Copalis and Hoquiam soils. Also included in some mapped areas is as much as 10 percent Nordby soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Nordby soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more, but there are few roots below a depth of 30 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 172 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 129 for Douglas-fir and 119 for western hemlock. Yield tables

indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 183 cubic feet per acre per year, and for western hemlock at age 50 it is 266 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are slippery. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit. This unit is well suited to year-round logging operations except during the short periods when the soil is wet. Steep cuts and fills that have no plant cover readily ravel and slough. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. Droughtiness of the surface layer increases seedling mortality. Seedlings planted in the less fertile subsoil grow poorly and have poor vigor. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, vine maple, western brackenfern, and western swordfern.

This map unit is in capability subclass IVe.

100-Nordby very gravelly loam, 30 to 65 percent slopes. This very deep, somewhat excessively drained soil is on benches and terraces. It formed in valley and continental glacial outwash. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 300 to 900 feet. The average annual precipitation is 80 to 130 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaf litter about 3 inches thick. The surface layer is dark reddish brown very gravelly loam about 12 inches thick. The subsoil is dark brown extremely gravelly sandy loam about 16 inches thick. The upper 15 inches of the substratum is dark brown extremely gravelly loamy sand, and the lower part to a depth of 60 inches or more is dark yellowish brown extremely gravelly sand.

Included in this unit is about 15 percent Copalis and Hoquiam soils. Also included in some mapped areas is as much as 15 percent Nordby soils that have slopes of less than 30 percent.

Permeability of this Nordby soil is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more, but there are few roots below a depth of 30 inches. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 172 for Douglas-fir and 166 for western hemlock. On the basis of a 50-year site curve, the mean site index is 129 for Douglas-fir and 119 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 183 cubic feet per acre per year, and for western hemlock at age 50 it is 266 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit. Steep cuts and fills that have no plant cover readily ravel and slough.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. Droughtiness of the surface layer increases seedling mortality. Seedlings planted in the less fertile subsoil grow poorly and have poor vigor. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, vine maple, western brackenfern, and western swordfern.

This map unit is in capability subclass VIe.

101-Norma sandy loam. This very deep, poorly drained soil is on narrow flood plains. It formed in sandy alluvium. The slope is 0 to 2 percent. The native vegetation is mainly hardwoods. Elevation is 200 to 400 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaves, twigs, and moss about 1 inch thick. The surface layer is very dark grayish brown sandy loam about 10 inches thick. The subsoil is mottled, grayish brown sandy loam about 19 inches thick. The substratum to a depth of 60 inches or more is dark gray sandy loam.

Included in this unit are about 5 percent Montesa soils, 5 percent Salzer soils, and 5 percent Norma soils that are drained.

Permeability of this Norma soil is moderately rapid. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that ranges from a depth of 12 inches to above the surface from November through April. Runoff is slow or ponded, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some small areas are used for hay and pasture.

Red alder is the principal forest species on this unit. Trees of limited extent include western redcedar, western hemlock, and bigleaf maple. On the basis of a 50-year site curve, the mean site index for red alder is about 90. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is about 101 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. The seasonal high water table and ponding restrict the use of equipment to the dry summer months. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western redcedar seedlings. If seed trees are present, natural reforestation by red alder occurs readily. Ponding and the seasonal high water table reduce root respiration and seedling survival. If openings are made in the canopy, invading brushy plants can delay establishment of planted seedlings. The restricted rooting depth, caused by the high water table, frequently causes windthrow.

Common forest understory species include salal, western swordfern, Oregon-grape, hazelnut, and vine maple.

If this unit is used for hay or pasture, the main limitation is the seasonal high water table. The high water table can be lowered by installing tile drains or open ditches if adequate outlets are available. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

This map unit is in capability subclass VIw.

102-Nuby silt loam. This very deep, poorly drained soil is on flood plains. Drainage has been altered by ditching and tiling. The soil formed in alluvium. The slope is 0 to 3 percent. The native vegetation is mainly conifers and hardwoods. Elevation is 20 to 100 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, the average growing season (at 28 degrees) is 180 to 220 days, and the average frost-free season (at 32 degrees) is 150 to 200 days.

Typically, the surface layer is mottled, grayish brown silt loam about 7 inches thick. The underlying material to a depth of 60 inches or more is mottled, light brownish gray and dark grayish brown silt loam.

Included in this unit are about 5 percent Aabab soils, 5 percent Grehalem soils, 2 percent Humptulis soils, and 10 percent Ocosta soils. Also included in some mapped areas is as much as 15 percent Nuby soils that are not drained.

Permeability of this Nuby soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 36 inches from October through April. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to occasional, very brief periods of flooding in winter.

Most areas of this unit are used for hay, pasture, and corn silage (fig. 18). Some areas are used as woodland, cropland, or rural homesites.

This unit is well suited to hay and pasture. The main limitations are soil wetness and the hazard of flooding. Flooding can be controlled by diking the adjacent streams or diverting upland runoff away from the area. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

Red alder is the principal forest species on this unit. Trees of limited extent include western redcedar, western hemlock, and bigleaf maple. On the basis of a 50-year site curve, the mean site index for red alder is 103. Yield tables indicate that mean annual increment at culmination (CMAI) for red alder at age 40 is 123 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Occasional, very brief flooding and the seasonal high water table restrict the use of equipment to dry summer months. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western redcedar seedlings. If seed trees are present, natural reforestation by red alder occurs readily. Occasional, very brief flooding and the seasonal high water table reduce root respiration and can result in seedling mortality. If openings are made in the canopy, invading brushy plants can delay establishment of western redcedar seedlings. The restricted rooting depth, caused by the seasonal high water table, frequently causes windthrow.

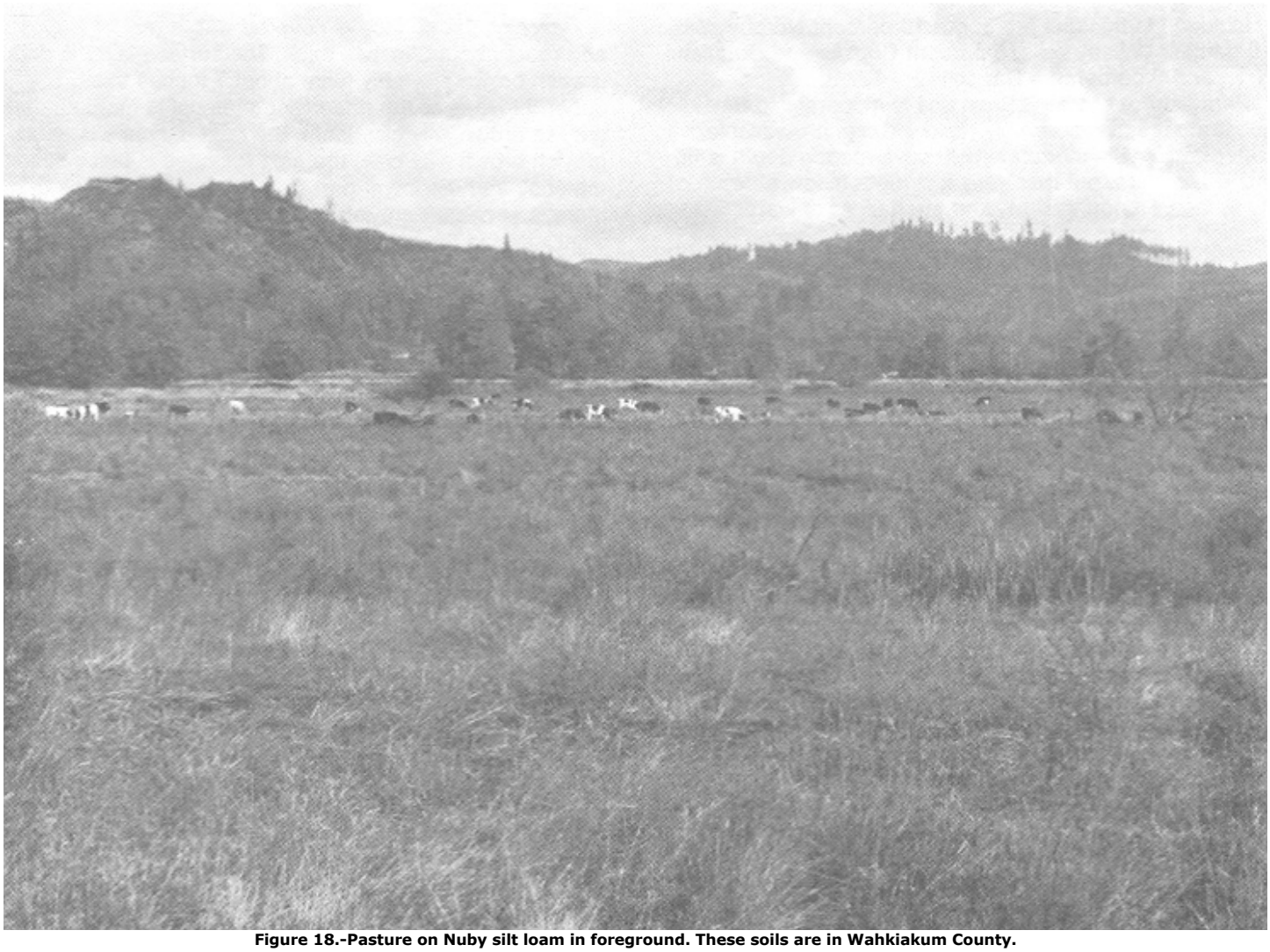

Figure 18.-Pasture on Nuby silt loam in foreground. These soils are in Wahkiakum County.

Common forest understory species include salal, salmonberry, vine maple, red huckleberry, and western swordfern.

If this unit is used for homesite development, the main limitations are the seasonal high water table and the hazard of flooding. Tile drainage can be used to lower the water table if suitable outlets are available. Dikes and channels that have outlets for floodwater can be used to protect buildings and onsite sewage disposal systems from flooding. Roads and streets should be located above the expected flood level.

This map unit is in capability subclass IIIw.

103-O'Brien silt loam, 1 to 15 percent slopes. This very deep, well drained soil is on terraces and uplands. It formed in glacial outwash. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 500 feet. The average annual precipitation is 90 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 3 inches thick. The surface layer is very dark grayish brown silt loam about 13 inches thick. The upper part of the subsoil is brown silt loam about 15 inches thick, and the lower part is dark yellowish brown gravelly silt loam about 3 inches thick. The upper part of the substratum is yellowish brown very gravelly loam about 4 inches thick, and the lower part to a depth of 60 inches or more is brown very gravelly sandy loam.

Included in this unit are about 10 percent Nordby soils, 10 percent Willaby soils, 5 percent Copalis and Hoquiam soils, and 5 percent Le Bar soils.

Permeability of this O'Brien soil is moderate to the substratum and moderately rapid through it. Available water capacity is moderate. Effective rooting depth is 60 inches or more, but there are few roots below a depth of 30 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder and western redcedar. On the basis of a 100-year site curve, the mean site index is 173 for Douglas-fir and 157 for western hemlock. On the basis of a 50-year site curve, the mean site index is 130 for Douglas-fir and 112 for western hemlock. Yield tables indicate that mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 184 cubic feet per acre per year, and for western hemlock at age 50 it is 249 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit, generally at a depth of 2 to 3 feet. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, western brackenfern, western swordfern, and red huckleberry.

This map unit is in capability subclass IIIe.

104-Ocosta silty clay loam. This very deep, poorly drained soil is on flood plains and deltas protected from tidal overflow. Drainage has been altered by ditching, tiling, and pumping. The soil formed in clayey alluvium deposited in the quiet water of coastal bays. The slope is 0 to 2 percent. The native vegetation is mainly grass and sedges. Elevation is sea level to 20 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is about 50 degrees F, the average growing season (at 28 degrees) is 200 to 240 days, and the average frost-free season (at 32 degrees) is 150 to 200 days.

Typically, the surface is covered with a mat of leaves and roots about 3 inches thick. The surface layer is dark grayish brown silty clay loam about 7 inches thick. The upper 5 inches of the underlying material is mottled, dark grayish brown silty clay loam, the next 8 inches is dark grayish brown silty clay, the next 2 inches is black sapric material, and the lower part to a depth of 60 inches or more is very dark grayish brown clay.

Included in this unit are about 10 percent Nuby and Rennie soils and 2 percent Seastrand soils. Also included in some mapped areas is as much as 40 percent soils that are not protected by dikes from tidal overflow.

Permeability of this Ocosta soil is very slow. Available water capacity is high. Effective rooting depth is limited by a high water table that is at a depth of 12 to 24 inches throughout the year. Runoff is slow, and the hazard of water erosion is slight. In undiked areas, this soil is subject to frequent, very brief periods of flooding.

Most areas of this unit are used for hay and pasture. Some areas are used as woodland. A few small areas are used as rural homesites.

The main limitation for hay and pasture is the high water table. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

Red alder and Sitka spruce are the principal forest species on this unit. Trees of limited extent include western redcedar and western hemlock. On the basis of a 50-year site curve, the mean site index for red alder is 94. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is 108 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Frequent, very brief flooding and the high water table restrict the use of equipment to the dry summer months. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western redcedar and Sitka spruce seedlings. If seed trees are present, natural reforestation by red alder occurs readily. Frequent, very brief floods and the high water table reduce root respiration and cause seedling mortality. If openings are made in the canopy, invading brushy plants can delay establishment of planted seedlings. The restricted rooting depth, caused by the high water table, frequently causes windthrow.

Common forest understory species include salal, salmonberry, vine maple, red huckleberry, and western swordfern.

If this unit is used for homesite development, the main limitations are the high water table, the shrink-swell potential, and the hazard of flooding. Tile drainage can be used to lower the water table if suitable outlets are available. The effects of shrinking and swelling can be minimized by using a proper engineering design and by backfilling with material that has low shrink-swell potential. Dikes need to be maintained to control flooding. Septic tank absorption fields do not function properly because of wetness and the very slow permeability.

This map unit is in capability subclass IVw.

105-Olympic clay loam, 1 to 8 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 250 to 1,800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 2 inches thick. The upper 7 inches of the surface layer is dark brown clay loam, and the lower 5 inches is dark brown silty clay loam. The upper 8 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is dark brown and yellowish red silty clay.

Included in this unit are about 10 percent Buckpeak, Centralia, and Melbourne soils and 5 percent Raught soils. Also included in some mapped areas is as much as 10 percent Olympic soils that have slopes of more than 8 percent.

Permeability of this Olympic soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used as rural homesites.

Douglas-fir and red alder are the principal forest species on this unit. Trees of limited extent include western hemlock, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 175, and on the basis of a 50-year site curve, the mean site index is 133. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 186 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include salal, Oregon-grape, vine maple, red huckleberry, and western swordfern.

If this unit is used for homesite development, the main limitation is the shrink-swell potential. The effects of shrinking and swelling can be minimized by using a proper engineering design and by backfilling with material that has low shrink-swell potential. Septic tank absorption fields do not function properly because of the moderately slow permeability.

This map unit is in capability subclass IIe.

106-Olympic clay loam, 8 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 250 to 1,800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 2 inches thick. The upper part of the surface layer is dark brown clay loam about 7 inches thick, and the lower part is dark brown silty clay loam about 7 inches thick. The upper part of the subsoil is dark brown silty clay loam about 8 inches thick, and the lower part to a depth of 60 inches or more is dark brown and yellowish red silty clay.

Included in this unit are about 10 percent Buckpeak, Centralia, and Melbourne soils and 15 percent Raught soils. Also included in some mapped areas is as much as 10 percent Olympic soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Olympic soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and red alder are the principal forest species on this unit. Trees of limited extent include western hemlock, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 175, and on the basis of a 50-

year site curve, the mean site index is 133. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 186 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include salal, Oregon-grape, vine maple, red huckleberry, and western swordfern.

This map unit is in capability subclass IVe.

107-Olympic clay loam, 30 to 65 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 250 to 1,800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 2 inches thick. The upper part of the surface layer is dark brown clay loam about 5 inches thick, and the lower part is dark brown silty clay loam about 5 inches thick. The upper part of the subsoil is dark brown silty clay loam about 15 inches thick, and the lower part to a depth of 60 inches or more is dark brown and yellowish red silty clay.

Included in this unit are about 5 percent Buckpeak, Centralia, and Melbourne soils and 15 percent Raught soils. Also included in some mapped areas is as much as 10 percent Olympic soils that have slopes of less than 30 percent.

Permeability of this Olympic soil is moderately slow. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and red alder are the principal forest species on this unit. Trees of limited extent include western hemlock, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 175, and on the basis of a 50-year site curve, the mean site index is 133. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 186 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include salal, Oregon-grape, vine maple, red huckleberry, and western swordfern.

This map unit is in capability subclass VIe.

108-Orcas peat. This very deep, very poorly drained soil is in flat-bottomed depressional areas or basins, in or between sand dunes. Drainage has been altered by ditching. The soil formed in sphagnum and hypnum moss. The native vegetation is mainly living spagnum moss, Labrador tea, rushes, and sedges. The slope is 0 to 1 percent. Elevation is 10 to 30 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season (at 32 degrees) is 160 to 180 days.

Typically, the surface is covered with a mat of moss and roots about 4 inches thick. The soil is dark reddish brown sphagnum peat to a depth of 60 inches or more.

Included in this unit is about 10 percent Seastrand Variant soils. Also included in some mapped areas are as much as 5 percent Seastrand soils, 5 percent Yaquina soils, and 35 percent Orcas soils that are not drained.

Permeability of this Orcas soil is very rapid. The available water capacity is high. Effective rooting depth is limited by a controlled water table that is at a depth of 6 to 18 inches throughout the year. Runoff is very slow, and water erosion is not a hazard.

Most areas of this unit are used for cultivating cranberries. Some areas are used as habitat for wetland wildlife or as pasture.

This unit is well suited to cranberries. Regulation of the water table is necessary to control the rate of subsidence in the cranberry bogs. Bogs are mulched with a layer of sand to control weeds and reduce oxidation. Sprinkler irrigation is used to minimize frost damage. Under a high level of management, this unit is capable of producing 7 to 10 tons of cranberries per acre per year.

If this unit is used for pasture, the main limitation is the high water table. The water table can be lowered by installing tile drains or open ditches if adequate outlets are available. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

This map unit is in capability subclass VIw.

109-Oyhut silt loam, 1 to 15 percent slopes. This moderately deep, moderately well drained soil is on terraces. It formed in material weathered from glacial outwash. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 300 feet. The average annual precipitation is 90 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of partially decomposed wood, twigs, and needles about 7 inches thick. The surface layer is very dark grayish brown silt loam about 9 inches thick. The upper part of the subsoil is dark brown silt loam about 15 inches thick, and the lower part is yellowish brown gravelly silt loam about 5 inches thick. Iron-cemented, dense glacial outwash is at a depth of about 29 inches. Depth to glacial outwash ranges from 24 to 40 inches.

Included in this unit are about 15 percent Halbert soils and 10 percent Mopang and Papac soils. Also included in some mapped areas is as much as 5 percent Calawah soils.

Permeability of this Oyhut soil is moderate to the dense glacial outwash and slow through it. Available water capacity is moderate. Effective rooting depth is 24 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. Water is perched above the glacial outwash from November to April. The effect of the outwash layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include western redcedar, Sitka spruce, red alder, and Douglas-fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 154, and on the basis of a 50-year site curve, the mean site index is 110. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 244 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit, generally at a depth of 3 to 5 feet. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. The restricted rooting depth, caused by the dense glacial outwash, occasionally causes windthrow.

Common forest understory species include salal, red huckleberry, blue huckleberry, Indian plum, and western swordfern.

This map unit is in capability subclass IIIe.

110-Oyhut silt loam, cool, 1 to 15 percent slopes. This moderately deep, moderately well drained soil is on terraces. It formed in weathered glacial outwash. The native vegetation is mainly conifers. Elevation is 50 to 200 feet. The average annual precipitation is 90 to 110 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of partially decomposed wood, twigs, and needles about 7 inches thick. The surface layer is very dark grayish brown silt loam about 9 inches thick. The upper part of the subsoil is dark brown silt loam about 15 inches thick, and the lower part is yellowish brown gravelly silt loam about 5 inches thick. Iron-cemented, dense glacial outwash is at a depth of about 29 inches. Depth to glacial outwash ranges from 24 to 40 inches.

Included in this unit are about 15 percent Halbert soils and 10 percent Mopang, cool, soils and Papac soils. Also included in some mapped areas is as much as 5 percent Calawah, cool, soils.

Permeability of this Oyhut soil is moderate to the dense glacial outwash and slow through it. Available water capacity is moderate. Effective rooting depth is 24 to 40 inches. Water is perched above the glacial outwash from November to April. The effect of the outwash layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is about 140, and on the basis of a 50-year site curve, the mean site index is about 100. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 60 is about 218 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded pebbles and cobbles are readily available in areas of this unit, generally at a depth of 3 to 5 feet. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily in cutover areas and by Sitka spruce it occurs periodically. If openings are made in canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock and Sitka spruce. The restricted rooting depth, caused by the dense glacial outwash, occasionally causes windthrow.

Common forest understory species include salal, red huckleberry, blue huckleberry, Indian plum, and western swordfern.

This map unit is in capability subclass IVe.

111-Palix silt loam, 8 to 30 percent slopes. This deep, well drained soil is on slumps of uplands. It formed in colluvium derived from siltstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,100 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown silt loam about 18 inches thick. The subsoil is dark yellowish brown, strong brown, and yellowish brown silty clay loam about 28 inches thick. Partly consolidated siltstone is at a depth of about 46 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 5 percent Narel and Lebam soils, 1 percent Knappton soils, 2 percent Swem soils, and 1 percent Stimson soils. Also included in some mapped areas are as much as 5 percent Palix soils that have slopes of more than 30 percent and 10 percent soils that are less than 40 inches deep to consolidated siltstone.

Permeability of this Palix soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to slippage.

This unit is used as woodland.

Western hemlock and Douglas-fir are the principal forest species on this unit. Trees of limited extent include red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 168, and on the basis of a 50-year site curve, the mean site index is 119. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 270 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Slumping and road failures can occur in clear-cut areas. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, red huckleberry, vine maple, western swordfern, and western brackenfern.

This map unit is in capability subclass IVe.

112-Palix silt loam, 30 to 65 percent slopes. This deep, well drained soil is on slumps of uplands. It formed in colluvium derived from siltstone. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,100 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown silt loam about 14 inches thick. The subsoil is dark yellowish brown, strong brown, and yellowish brown silty clay loam about 32 inches thick. Partly consolidated siltstone is at a depth of about 46

inches. Depth to weathered bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 5 percent Narel and Lebam soils, 1 percent Knappton soils, 2 percent Swem soils, and 1 percent Stimson soils. Also included in some mapped areas are as much as 5 percent Palix soils that have slopes of less than 30 percent or more than 65 percent and 10 percent soils that are less than 40 inches deep to consolidated siltstone.

Permeability of this Palix soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. This soil is subject to slippage.

This unit is used as woodland.

Western hemlock and Douglas-fir are the principal forest species on this unit. Trees of limited extent include red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 160, and on the basis of a 50-year site curve, the mean site index is 112. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 254 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, red huckleberry, vine maple, western swordfern, and western brackenfern.

This map unit is in capability subclass VIe.

113-Palix silt loam, 65 to 90 percent slopes. This deep, well drained soil is on slumps of uplands. It formed in colluvium derived from siltstone. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,100 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown silt loam about 12 inches thick. The subsoil is dark yellowish brown, strong brown, and yellowish brown silty clay loam about 28 inches thick. Partly consolidated siltstone is at a depth of about 40 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 5 percent Narel soils, 2 percent Knappton soils, and 2 percent Swem soils. Also included in some mapped areas are as much as 5 percent Palix soils that have slopes of less than 65 percent and 10 percent soils that are less than 40 inches deep to consolidated siltstone.

Permeability of this Palix soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe. This soil is subject to slippage.

This unit is used as woodland.

Western hemlock and Douglas-fir are the principal forest species on this unit. Trees of limited extent include red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 160, and on the basis of a 50-year site curve, the mean site index is 112. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 254 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, red huckleberry, vine maple, western swordfern, and western brackenfern.

This map unit is in capability subclass VIIe.

114-Palix silt loam, cool, 8 to 30 percent slopes. This deep, well drained soil is on slumps of uplands. It formed in colluvium derived from siltstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,100 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown silt loam about 18 inches thick. The subsoil is dark yellowish brown, strong brown, and yellowish brown silty clay loam about 40 inches thick. Partly consolidated siltstone is at a depth of about 58 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 5 percent Ilwaco, cool, soils and Lebam, cool, soils; 1 percent Vesta, cool, soils; 2 percent Swem soils; and 1 percent Stimson soils. Also included in some mapped areas are as much as 5 percent Palix, cool, soils that have slopes of more than 30 percent and 10 percent soils that are less than 40 inches deep to consolidated siltstone.

Permeability of this Palix soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight. This soil is subject to slippage.

This unit is used as woodland.

Western hemlock and Sitka spruce are the principal forest species on this unit. Trees of limited extent include western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is about 147, and on the basis of a 50-year site curve, the mean site index is about 105. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 232 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Slumping and road failure can occur in clear-cut areas. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salal, red huckleberry, vine maple, western swordfern, and western brackenfern.

This map unit is in capability subclass IVe.

115-Palix silt loam, cool, 30 to 65 percent slopes. This deep, well drained soil is on slumps of uplands. It formed in colluvium derived from siltstone. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,100 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown silt loam about 14 inches thick. The subsoil is dark yellowish brown, strong brown, and yellowish brown silty clay loam about 32 inches thick. Partly consolidated siltstone is at a depth of about 46 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 5 percent Ilwaco, cool, soils and Lebam, cool, soils; 1 percent Vesta, cool, soils; and 2 percent Swem soils. Also included in some mapped areas are as much as 5 percent Palix, cool, soils that have slopes of less than 30 percent or more than 65 percent and 10 percent soils that are less than 40 inches deep to consolidated siltstone.

Permeability of this Palix soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate. This soil is subject to slippage.

This unit is used as woodland.

Western hemlock and Sitka spruce are the principal forest species on this unit. Trees of limited extent include western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is about 147, and on the basis of a 50-year site curve, the mean site index is about 105. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 232 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily

unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salal, red huckleberry, vine maple, western swordfern, and western brackenfern.

This map unit is in capability subclass VIe.

116-Palix silt loam, cool, 65 to 90 percent slopes. This deep, well drained soil is on slumps of uplands. It formed in colluvium derived from siltstone. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 1,100 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles and twigs about 1 inch thick. The surface layer is very dark grayish brown silt loam about 12 inches thick. The subsoil is dark yellowish brown, strong brown, and yellowish brown silty clay loam about 28 inches thick. Partly consolidated siltstone is at a depth of about 40 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 5 percent Willapa, cool, soils and 1 percent Vesta, cool, soils. Also included in some mapped areas are as much as 15 percent Palix, cool, soils that have slopes of less than 65 percent and 10 percent soils that are less than 40 inches deep to consolidated siltstone.

Permeability of this Palix soil is moderate. Available water capacity is high. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe. This soil is subject to slippage.

This unit is used as woodland.

Western hemlock and Sitka spruce are the principal forest species on this unit. Trees of limited extent include western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is about 147, and on the basis of a 50-year site curve, the mean site index is about 105. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 232 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rifling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salal, red huckleberry, vine maple, western swordfern, and western brackenfern.

This map unit is in capability subclass VIIe.

117-Papac gravelly silt loam, 1 to 8 percent slopes. This moderately deep, well drained soil is on glacial terraces. It formed in weathered glacial drift. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 3 inches thick. The surface layer is very dark brown and very dark grayish brown gravelly silt loam about 15 inches thick. The upper 4 inches of the subsoil is dark yellowish brown gravelly silt loam, and the lower part is dark brown and yellowish brown gravelly silty clay loam about 19 inches thick. Light olive brown, dense glacial till is at a depth of about 38 inches. Depth to the glacial till ranges from 20 to 40 inches.

Included in this unit are about 10 percent Halbert and Wishkah soils and 15 percent Mopang soils. Also included in some mapped areas are as much as 10 percent Papac soils that have slopes of more than 8 percent.

Permeability of this Papac soil is moderate to the dense glacial till and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. The effect of the till layer on use and management is similar to the effect of a hardpan.

Most areas of this unit are used as woodland. Some areas are used as rural homesites.

Western hemlock is the principal forest species on this unit. Trees of limited extent include western redcedar, Sitka spruce, red alder, and Douglas-fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 160, and on the basis of a 50-year site curve, the mean site index is 114. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 254 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit, generally at a depth of 3 to 5 feet. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. The restricted rooting depth, caused by the dense glacial till, occasionally causes windthrow.

Common forest understory species include salal, blue huckleberry, western swordfern, red elderberry, and red huckleberry.

If this unit is used for homesite development, the main limitation is the dense glacial till at a depth of 20 to 40 inches. The glacial till is rippable; therefore, it is not a serious limitation for most engineering uses. Because of the very slow permeability of the till, onsite sewage disposal systems often fail or do not function properly.

This map unit is in capability subclass IIIe.

118-Papac gravelly silt loam, 8 to 30 percent slopes. This moderately deep, well drained soil is on glacial terraces. It formed in weathered glacial drift. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 3 inches thick. The surface layer is very dark brown and very dark grayish brown gravelly silt loam about 12 inches thick. The upper 4 inches of the subsoil is dark yellowish brown gravelly silt loam, and the lower part is dark brown and yellowish brown gravelly silty clay loam about 17 inches thick. Light olive brown, dense glacial till is at a depth of about 33 inches. Depth to the glacial till ranges from 20 to 40 inches.

Included in this unit are about 5 percent Halbert and Wishkah soils and 15 percent Mopang soils. Also included in some mapped areas is as much as 15 percent Papac soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Papac soil is moderate to the dense glacial till and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. The effect of the till layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include western redcedar, Sitka spruce, red alder, and Douglas-fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 152, and on the basis of a 50-year site curve, the mean site index is 108. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 241 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit, generally at a depth of 3 to 5 feet. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. The restricted rooting depth, caused by the dense glacial till, occasionally causes windthrow.

Common forest understory species include salal, blue huckleberry, western swordfern, red elderberry, and red huckleberry.

This map unit is in capability subclass IVe.

119-Papac gravelly silt loam, 30 to 65 percent slopes. This moderately deep, well drained soil is on glacial terrace escarpments. It formed in weathered glacial drift. Drainageways generally are 1,000 to 1,500

feet apart. The native vegetation is mainly conifers. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 3 inches thick. The surface layer is very dark brown and very dark grayish brown gravelly silt loam about 10 inches thick. The upper 4 inches of the subsoil is dark yellowish brown gravelly silt loam, and the lower part is dark brown and yellowish brown gravelly silty clay loam about 16 inches thick. Light olive brown, dense glacial till is at a depth of about 30 inches. Depth to the glacial till ranges from 20 to 40 inches.

Included in this unit is about 15 percent Mopang soils. Also included in some mapped areas is as much as 10 percent Papac soils that have slopes of less than 30 percent.

Permeability of this Papac soil is moderate to the dense glacial till and very slow through it. Available water capacity is moderate. Effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The effect of the till layer on use and management is similar to the effect of a hardpan.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include western redcedar, Sitka spruce, red alder, and Douglas-fir. On the basis of a 100-year site curve, the mean site index for western hemlock is about 152, and on the basis of a 50-year site curve, the mean site index is about 108. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 241 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit, generally at a depth of 3 to 5 feet. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. The restricted rooting depth, caused by the dense glacial till, occasionally causes windthrow.

Common forest understory species include salal, blue huckleberry, western swordfern, red elderberry, and red huckleberry.

This map unit is in capability subclass VIe.

120-Pits, gravel. This map unit consists of open excavations from which the soil and underlying rounded gravel and stones of glacial origin have been removed. The unit supports little or no vegetation.

The excavated gravelly material is used mainly as a source of gravel for concrete and as top dressing and ballast for logging roads.

This map unit is in capability subclass VIIIs.

121-Pits, quarries. This map unit consists of open excavations from which the soil and underlying parent material have been removed. Basalt is exposed at the bottom of these pits. The unit supports little or no vegetation.

This unit is used mainly as a source of gravel for construction, material for protection of channels, and road ballast.

This map unit is in capability subclass VIIIs.

122-Raught silt loam, 5 to 30 percent slopes. This very deep, well drained soil is on shoulders of uplands. It formed in material derived from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaf litter about 1 inch thick. The surface layer is dark reddish brown silt loam about 10 inches thick. The subsoil to a depth of 60 inches or more is dark reddish brown and dark red silt loam.

Included in this unit are about 5 percent Cathlamet and Germany soils, 1 percent Stimson soils, and 3 percent Raught soils that have slopes of more than 30 percent. Also included in some mapped areas is as much as 10 percent soils that are less than 60 inches deep to bedrock.

Permeability of this Raught soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly as woodland. It is also used as rural homesites.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is

176 for Douglas-fir and 162 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 115 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 187 cubic feet per acre per year, and for western hemlock at age 50 it is 258 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 7 feet. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily and by western hemlock it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salmonberry, salal, Oregon-grape, vine maple, and western swordfern.

If this unit is used for homesite development, the main limitation is steepness of slope. The slope is a concern in installing septic tank absorption fields. Absorption lines should be installed on the contour.

This map unit is in capability subclass IVe.

123-Raught silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on back slopes of uplands. It formed in material derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaf litter about 1 inch thick. The surface layer is dark reddish brown silt loam about 7 inches thick. The subsoil to a depth of 60 inches or more is dark reddish brown and dark red silt loam.

Included in this unit are about 5 percent Cathlamet and Germany soils, 1 percent Raught soils that have a gravelly surface layer, and 5 percent Raught soils that have slopes of less than 30 percent or more than 65 percent. Also included in some mapped areas is as much as 10 percent soils that are less than 60 inches deep to bedrock.

Permeability of this Raught soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 176 for Douglas-fir and 162 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 115 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 187 cubic feet per acre per year and for western hemlock at age 50 it is 258 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 7 feet. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily and by western hemlock it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, Oregon-grape, vine maple, and western swordfern.

This map unit is in capability subclass VIe.

124-Raught silt loam, 65 to 90 percent slopes. This very deep, well drained soil is on back slopes of uplands. It formed in material derived from basalt. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaf litter about 1 inch thick. The surface layer is dark reddish brown silt loam about 7 inches thick. The subsoil to a depth of 60 inches or more is dark reddish brown and dark red silt loam.

Included in this unit are about 5 percent Olympic soils, 10 percent Raught soils that have a gravelly surface layer, and 10 percent Raught soils that have slopes of less than 65 percent. Also included in some mapped areas is as much as 15 percent soils that are less than 60 inches deep to bedrock.

Permeability of this Raught soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is 176 for Douglas-fir and 162 for western hemlock. On the basis of a 50-year site curve, the mean site index is 131 for Douglas-fir and 115 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 187 cubic feet per acre per year, and for western hemlock at age 50 it is 258 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 7 feet. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily and by western hemlock it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salmonberry, salal, Oregon-grape, vine maple, and western swordfern.

This map unit is in capability subclass VIIe.

125-Rennie silty clay loam. This very deep, poorly drained soil is on flood plains. It formed in fine-textured alluvium derived from basic igneous and sedimentary rocks. The slope is 0 to 2 percent. The native vegetation is mainly conifers and hardwoods. Elevation is sea level to 100 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 180 to 200 days.

Typically, the surface layer is mottled, very dark grayish brown silty clay loam about 7 inches thick. The upper 6 inches of the subsoil is mottled, dark grayish brown silty clay loam, the next 25 inches is grayish brown silty clay, and the lower part to a depth of 54 inches is grayish brown clay. The substratum to a depth of 60 inches or more is gleyed, dark greenish gray clay.

Included in this unit are about 10 percent Nuby and Ocosta soils, 5 percent Salzer soils, and 5 percent Aabab soils. Also included is about 5 percent Grehalem soils and 20 percent Rennie soils that are drained.

Permeability of this Rennie soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that ranges from a depth of 6 inches to above the surface from October to May. Runoff is very slow or ponded, and the hazard of water erosion is slight. This soil is subject to frequent, brief periods of flooding from November to April.

This unit is used for hay, pasture, and woodland.

If this unit is used for hay and pasture, the main limitations are the hazard of flooding and the seasonal high water table. Flooding can be controlled by diking the adjacent streams or diverting upland runoff away from the area. The high water table can be lowered by installing tile drains or open ditches if adequate outlets are available. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

Red alder is the principal forest species on this unit. Trees of limited extent include western redcedar, western hemlock, and bigleaf maple. On the basis of a 50-year site curve, the mean site index for red alder is 99. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is 116 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. The hazard of flooding, the seasonal high water table, and ponding restrict the use of equipment to the dry summer months. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western redcedar seedlings. If seed trees are present, natural reforestation

by red alder occurs readily. The hazard of flooding, the seasonal high water table, and ponding reduce root respiration and cause seedling mortality. If openings are made in the canopy, invading brushy plants can delay establishment of planted seedlings. The restricted rooting depth, caused by the high water table, frequently causes windthrow.

Common forest understory species include salmonberry, devilsclub, skunkcabbage, vine maple, and sedge.

This map unit is in capability subclass Vlw.

126-Riverwash. This map unit consists of nearly level bars of clayey, silty, sandy, or gravelly alluvium of recent origin. It is in areas adjacent to perennial and intermittent streams and is periodically flooded by runoff from melting snow and heavy rains. This unit has a very sparse plant cover consisting of brush and deciduous trees.

This unit is used mainly as a source of gravel for construction, material for protection of channels, and road ballast. It is also used for recreation and as wildlife habitat.

This map unit is in capability subclass VIIIw.

127-Salzer silty clay. This very deep, very poorly drained soil is in swales, depressional areas, and old abandoned stream channels on flood plains. It formed in fine-textured alluvium derived dominantly from sedimentary rock. The slope is 0 to 2 percent. The native vegetation is mainly grasses and sedges with scattered conifers and hardwoods. Elevation is 25 to 200 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is about 51 degrees F, and the average growing season (at 28 degrees) is 150 to 200 days.

Typically, the surface layer is mottled, dark grayish brown silty clay about 6 inches thick. The upper 15 inches of the subsoil is mottled, dark gray clay, the next 8 inches is olive gray clay, and the lower part to a depth of 50 inches is gray clay. The upper 9 inches of the substratum is grayish brown silty clay loam, and the lower part to a depth of 60 inches or more is dark grayish brown sandy clay loam. When dry for short periods, the soil commonly has 1/2-inch cracks extending from the surface to a depth of 24 inches.

Included in this unit are about 10 percent Nuby and Rennie soils, 5 percent Aabab soils, 5 percent Grehalem soils, and 15 percent Salzer soils that have been drained.

Permeability of this Salzer soil is very slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that ranges from a depth of 6 inches to above the surface from October to May. Runoff is very slow or ponded, and the hazard of water erosion is slight. This soil is subject to frequent, long periods of flooding from November to April.

This unit is used for hay, pasture, and woodland.

If this unit is used for hay and pasture, the main limitations are the hazard of flooding and the seasonal high water table. Flooding can be controlled by diking the adjacent streams or by diverting upland runoff away from the area. The high water table can be lowered by installing tile drains or open ditches if adequate outlets are available. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

Red alder is the principal forest species on this unit. Trees of limited extent include western redcedar, western hemlock, and bigleaf maple. On the basis of a 50-year site curve, the mean site index for red alder is about 85. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is about 92 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. The hazard of flooding, the seasonal high water table, and ponding restrict the use of equipment to the dry summer months. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western redcedar seedlings. If seed trees are present, natural reforestation by red alder occurs readily. The hazard of flooding, the seasonal high water table, and ponding reduce root respiration and cause seedling mortality. If openings are made in the canopy, invading brushy plants can delay establishment of planted seedlings. The restricted rooting depth, caused by the high water table, frequently causes windthrow.

Common forest understory species include salmonberry, devilsclub, skunkcabbage, vine maple, and sedge.

This map unit is in capability subclass Vlw.

128-Satsop silt loam, 1 to 8 percent slopes. This very deep, well drained soil is on alluvial fans and stream terraces. It formed in alluvium. The native vegetation is mainly conifers. Elevation is 30 to 300 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark brown silt loam about 7 inches thick. The subsoil is olive brown silt loam about 21 inches thick. The substratum to a depth of 60 inches or more is light olive brown very fine sandy loam.

Included in this unit are about 10 percent Skamo soils and 10 percent Montesa soils.

Permeability of this Satsop soil is moderately rapid. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland, hay, pasture, and rural homesites.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include western hemlock, red alder, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 179, and on the basis of a 50-year site curve, the mean site index is 136. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 190 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include western brackenfern, western swordfern, salal, cascara buckthorn, and devilsclub.

This unit is well suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is necessary to reduce soil erosion.

This unit is well suited to homesite development. Excavation for roads and buildings increases the risk of erosion. Preserving the existing plant cover during construction helps to control erosion. Plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes.

This map unit is in capability subclass IIe.

129-Sauvie silt loam. This very deep, poorly drained soil is on flood plains protected from tidal overflow. Drainage has been altered by ditching, tiling, and pumping. The soil formed in alluvium. The slope is 0 to 2 percent. The native vegetation is mainly grasses and hardwoods. Elevation is 10 to 20 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 53 degrees F, and the average frost-free season (at 32 degrees) is 165 to 200 days.

Typically, the surface layer is mottled, very dark grayish brown silt loam about 10 inches thick. The subsoil is mottled, dark grayish brown and dark gray silty clay loam about 16 inches thick. The substratum to a depth of 60 inches or more is dark gray silt loam.

Included in this unit are about 5 percent Sauvie soils that have a silty clay loam surface layer and 2 percent Sauvie soils that have strata of sandy loam to loam at a depth of about 30 inches. Also included is about 1 percent soils that have as much as 10 inches of muck in the subsoil.

Permeability of this Sauvie soil is moderately slow. Available water capacity is high. Effective rooting depth is limited by a high water table that is at a depth of 24 to 48 inches throughout the year. Runoff is slow, and the hazard of water erosion is slight. This soil is rarely flooded. Flooding is caused by dike breakage.

This unit is used for hay, pasture, cultivated crops, and rural homesites.

This unit is well suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

This unit is well suited to most climatically adapted crops. Deep-rooted crops are suited to areas where a drainage system has been installed. In summer, irrigation is needed for maximum production of most crops. Sprinkler irrigation is a suitable method because it permits the even, controlled application of water. Because of the moderately slow permeability of the soil, the application of water should be regulated so that water does not stand on the surface and damage crops. Returning all crop residue to the soil and growing green manure crops help to maintain fertility and tilth.

If this unit is used for homesite development, the main limitations are the high water table, shrink-swell potential, and hazard of flooding. Drainage is needed if roads and building foundations are constructed. Buildings and roads should be designed to offset the limited ability of the soil in this unit to support a load. The effects of shrinking and swelling can be minimized by using a proper engineering design and by backfilling with material that has a low shrink-swell potential. Dikes need to be maintained to control flooding. The moderately slow permeability and high water table increase the possibility of failure of septic tank absorption fields.

This map unit is in capability subclass IIw.

130-Schneider very gravelly silt loam, very deep, 8 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in colluvium derived from basalt. The native vegetation is mainly conifers. Elevation is 600 to 1,200 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 49 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The upper 10 inches of the surface layer is dark brown and dark reddish brown very gravelly silt loam, and the lower 17 inches is dark reddish brown very gravelly silt loam. The subsoil is dark brown extremely gravelly silt loam about 24 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely gravelly silt loam.

Included in this unit are about 5 percent Tebo soils and 10 percent Schneider soils that have slopes of more than 30 percent.

Permeability of this Schneider soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western hemlock, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 186, and on the basis of a 50-year site curve, the mean site index is 138. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 196 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. The droughtiness of the surface layer increases seedling mortality. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include salal, western swordfern, western brackenfern, vine maple, and Oregon-grape.

This map unit is in capability subclass IVe.

131-Schneider very gravelly silt loam, very deep, 30 to 65 percent slopes. This very deep, well drained soil is on uplands. It formed in colluvium derived from basalt. The native vegetation is mainly conifers. Elevation is 600 to 1,200 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 49 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The upper 10 inches of the surface layer is dark brown and dark reddish brown very gravelly silt loam, and the lower 12 inches is dark reddish brown very gravelly silt loam. The subsoil is dark brown extremely gravelly silt loam about 27 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown extremely gravelly silt loam.

Included in this unit are about 5 percent Tebo soils and 10 percent Schneider soils that have slopes of less than 30 percent.

Permeability of this Schneider soil is moderate. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is about 186, and on the basis of a 50-year site curve, the mean site index is about 138. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is about 196 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily. The droughtiness of the surface layer increases seedling mortality. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings.

Common forest understory species include salal, western swordfern, western brackenfern, vine maple, and Oregon-grape.

This map unit is in capability subclass VIe.

132-Seastrand mucky peat. This very deep, very poorly drained soil is in depressional areas between

sand dunes. Drainage has been altered by ditching. The soil formed in decomposed plant remains deposited over sand. The slope is 0 to 1 percent. The native vegetation is mainly conifers, rushes, and sedges. Elevation is 10 to 30 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season (at 32 degrees) is 160 to 180 days.

Typically, the surface layer is black, very dark brown, and dark reddish brown mucky peat about 30 inches thick. The underlying material to a depth of 60 inches or more is dark grayish brown sand. Depth to sand ranges from 20 to 48 inches. In some areas the underlying sand has thin layers of organic material.

Included in this unit are about 5 percent Seastrand Variant soils, 10 percent Yaquina soils, 2 percent Orcas soils, and 10 percent Seastrand mucky peat that has less than 10 inches of organic material over the underlying sand.

Permeability of this Seastrand soil is moderate in the surface layer and moderately rapid in the underlying material. Available water capacity is high. Effective rooting depth is limited by a controlled water table that is at a depth of 6 to 18 inches throughout the year. Runoff is very slow, and water erosion is not a hazard.

Most areas of this unit are used for cranberries. Some areas are used as habitat for wetland wildlife or as pasture.

This unit is well suited to cranberries. Regulation of the water table is necessary to control the rate of subsidence in the cranberry bogs. Bogs are mulched with a layer of sand to control weeds and reduce oxidation. Sprinkler irrigation is used to minimize frost damage. Under a high level of management, this unit is capable of producing 7 to 10 tons of cranberries per acre per year.

If this unit is used for pasture, the main limitation is the high water table. The water table can be lowered by installing tile drains or open ditches if adequate outlets are available. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

This map unit is in capability subclass Vlw.

133-Seastrand Variant muck. This very deep, very poorly drained soil is in depressional areas between stabilized sand dunes. Drainage has been altered by ditching. The soil formed in decomposed plant remains. The slope is 0 to 1 percent. The native vegetation is mainly conifers, sedges, and rushes. Elevation is sea level to 30 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season (at 32 degrees) is 160 to 180 days.

Typically, the surface is covered with a mat of needles, twigs, leaves, and bark about 3 inches thick. The surface layer is dark reddish brown muck about 18 inches thick. Below this to a depth of 60 inches or more is dark reddish brown mucky peat. Depth to mineral soil material ranges from 48 to 60 inches or more.

Included in this unit are about 10 percent Yaquina soils and 5 percent Orcas soils. Also included in some mapped areas is as much as 15 percent Seastrand soils.

Permeability of this Seastrand Variant soil is moderate. Available water capacity is high. Effective rooting depth is limited by a controlled water table that is at a depth of 6 to 18 inches throughout the year. Runoff is very slow, and water erosion is not a hazard.

Most areas of this unit are used for cranberries (fig. 19). Some areas are used as wetland wildlife habitat or pasture.

This unit is well suited to cranberries. Regulation of the water table is necessary to control the rate of subsidence in the cranberry bogs. Bogs are mulched with a layer of sand to control weeds and reduce oxidation. Sprinkler irrigation is used to minimize frost damage. Under a high level of management, this unit is capable of producing 7 to 10 tons of cranberries per acre per year.

If this unit is used for pasture, the main limitation is the high water table. The water table can be lowered by installing tile drains or open ditches if adequate outlets are available. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

This map unit is in capability subclass Vlw.

134-Skamo silt loam, 0 to 8 percent slopes. This very deep, moderately well drained soil is on terraces and alluvial fans. It formed in alluvium derived from sedimentary and igneous rocks. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 200 feet. The average annual precipitation is 50 to 90 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, twigs, leaves, and moss about 1.5 inches thick. The upper part of the surface layer is very dark brown and very dark grayish brown silt loam about 10 inches thick, and the lower part is dark brown silty clay loam about 9 inches thick. The upper part of the subsoil is dark yellowish brown silty clay loam about 10 inches thick, and the lower part to a depth of 48 inches is mottled, dark brown silty clay loam. The substratum to a depth of 60 inches or more is mottled, dark brown silty clay loam.

Included in this unit are about 15 percent Montesa soils and 2 percent Grehalem soils. Also included in some mapped areas is as much as 5 percent Satsop soils.

Permeability of this Skamo soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 36 inches from November to March. Runoff is slow, and the hazard of water erosion is slight.

Figure 19.-Suction picker harvesting cranberries on Seastrand Variant muck. These soils are in Grays Harbor County Area.

This unit is used as woodland, hay, pasture, and rural homesites.

Douglas-fir and red alder are the principal forest species on this unit. Trees of limited extent include western hemlock, bigleaf maple, and western redcedar. On the basis of a 100-year site curve, the mean site index is about 150 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is about 115 for Douglas-fir and 101 for red alder. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 158 cubic feet per acre per year, and for red alder at age 40 it is 120 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be

accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder and western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings. The restricted rooting depth, caused by the seasonal high water table, occasionally causes windthrow.

Common forest understory species include salmonberry, vine maple, red huckleberry, western swordfern, and red elderberry.

This unit is well suited to hay and pasture. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil. Adequate plant cover is required to prevent soil erosion.

If this unit is used for homesite development, the main limitation is the seasonal high water table. Tile drainage can be used to lower the water table if suitable outlets are available. Septic tank absorption fields do not function properly because of wetness.

This map unit is in capability subclass IIIe.

135-Spanaway very gravelly sandy loam, 1 to 8 percent slopes. This very deep, somewhat excessively drained soil is on glacial outwash terraces. It formed in very gravelly glacial outwash. The native vegetation is mainly grass and western brackenfern. Elevation is 100 to 200 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season (at 28 degrees) is about 200 to 240 days.

Typically, the surface is covered with a mat of decomposed moss about 1 inch thick. The surface layer is black very gravelly sandy loam about 11 inches thick. The subsoil is dark yellowish brown extremely gravelly sandy loam about 5 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown extremely gravelly sand.

Included in this unit are about 10 percent Lyre soils and 3 percent Carstairs and Lyre Variant soils.

Permeability of this Spanaway soil is moderately rapid. Available water capacity is low. Roots penetrate to a depth of 60 inches or more, but there are few roots below a depth of 30 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland, pasture, rural homesites, and hay. It is also used as a source of gravel and for Christmas trees.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include Oregon white oak, lodgepole pine, and red alder. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 140, and on the basis of a 50-year site curve, the mean site index is 108. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 145 cubic feet per acre per year.

This unit is well suited to year-round use of equipment. When wet, unsurfaced roads and skid trails are slippery. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by Douglas-fir, lodgepole pine, and Oregon white oak occurs infrequently. Droughtiness of the surface layer increases seedling mortality. Seedlings planted in the less fertile subsoil grow poorly and have poor vigor. If openings are made in the canopy, invading brushy plants can delay establishment of Douglas-fir seedlings.

Common forest understory species include Oregon-grape, salal, Indian plum, western swordfern, western brackenfern, and kinnikinnick.

Scotch pine and Douglas-fir can be planted and harvested for use as Christmas trees.

This unit is poorly suited to hay and pasture. The main limitations are the low available water capacity and low soil fertility. Because the soil in this unit is droughty, applications of irrigation water should be light and frequent. Sprinkler irrigation is a suitable method. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients.

This unit is well suited to homesite development. Removal of pebbles and cobbles in disturbed areas is necessary for best results in landscaping, particularly in areas used for lawns. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass IVs.

136-Squally gravelly silt loam, 5 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in landslide debris derived from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,500 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaves and needles about 1 inch thick. The surface layer is dark brown gravelly silt loam about 10 inches thick. The subsoil to a depth of 60 inches or more is dark reddish brown very gravelly fine sandy loam.

Included in this unit are about 5 percent Boistfort soils, 10 percent Bunker soils, and 2 percent Katula soils. Also

included in some mapped areas is as much as 10 percent Squally soils that have slopes of more than 30 percent.

Permeability of this Squally soil is rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, bigleaf maple, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index is 176 for Douglas-fir and 172 for western hemlock. On the basis of a 50-year site curve, the mean site index is 134 for Douglas-fir and 121 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 187 cubic feet per acre per year, and for western hemlock at age 50 it is 278 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. Seedlings planted in the less fertile subsoil grow poorly and have poor vigor. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salmonberry, salal, red elderberry, Oregon-grape, and western swordfern.

This map unit is in capability subclass IVe.

137-Squally gravelly silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on uplands. It formed in landslide debris derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,500 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaves and needles about 1 inch thick. The surface layer is dark brown gravelly silt loam about 12 inches thick. The subsoil to a depth of 60 inches or more is dark reddish brown very gravelly fine sandy loam.

Included in this unit are about 2 percent Boistfort soils, 10 percent Bunker soils, and 5 percent Katula soils. Also included in some mapped areas is as much as 10 percent Squally soils that have slopes of less than 30 percent.

Permeability of this Squally soil is rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, bigleaf maple, and Sitka spruce. On the basis of a 100-year site curve, the mean site index is 176 for Douglas-fir and 172 for western hemlock. On the basis of a 50-year site curve, the mean site index is 134 for Douglas-fir and 121 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 187 cubic feet per acre per year, and for western hemlock at age 50 it is 278 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur In clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. Seedlings planted in the less fertile subsoil grow poorly and have poor vigor. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salmonberry, salal, red elderberry, Oregon-grape, and western swordfern.

This map unit is in capability subclass VIe.

138-Stimson silt loam. This very deep, poorly drained soil is in depressional areas on uplands. It formed in alluvium derived from loess. The slope is 0 to

3 percent. The native vegetation is mainly conifers. Elevation is 500 to 1,500 feet. The average annual precipitation is 60 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaf litter about 2 inches thick. The surface layer is very dark brown and very dark gray silt loam about 11 inches thick. The subsoil is mottled, gray silty clay loam about 8 inches thick. The substratum to a depth of 60 inches or more is mottled, grayish brown silty clay loam.

Included in this unit are about 2 percent Germany and Lytell soils and 3 percent Swem soils.

Permeability of this Stimson soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that ranges from a depth of 6 inches to the surface from October to April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Red alder is the principal forest species on this unit. Trees of limited extent include western redcedar, bigleaf maple, and western hemlock. On the basis of a 50-year site curve, the mean site index for red alder is 95. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is 109 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western redcedar seedlings. If seed trees are present, natural reforestation by red alder occurs readily. The seasonal high water table causes seedling mortality. If openings are made in the canopy, invading brushy plants can delay establishment of western redcedar seedlings. The restricted rooting depth, caused by the high water table, frequently causes windthrow.

Common forest understory species include salmonberry, red huckleberry, western swordfern, Oregon-grape, and red elderberry.

This map unit is in capability subclass VIw.

139-Swem gravelly silt loam, 5 to 30 percent slopes. This very deep, moderately well drained soil is on back slopes and foot slopes of old earthflows. It formed in colluvium derived from basalt and deposited over marine sediment. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 500 to 1,400 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 1.5 inches thick. The surface layer is very dark brown gravelly silt loam about 15 inches thick. The upper 13 inches of the subsoil is mottled, yellowish brown gravelly silt loam, and the lower part to a depth of 60 inches or more is mottled, yellowish brown silt loam.

Included in this unit are about 10 percent Lytell soils, 5 percent Bunker and Zenker soils, 2 percent Astoria and Elochoman soils, and 2 percent Willapa soils. Also included in some mapped areas is as much as 10 percent Swem soils that have slopes of more than 30 percent.

Permeability of this Swem soil is moderately slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 30 to 42 inches from November to March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, bigleaf maple, and Sitka spruce. On the basis of a 100-year site curve, the mean site index is 163 for Douglas-fir and 161 for western hemlock. On the basis of a 50-year site curve, the mean site index is 125 for Douglas-fir and 114 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 173 cubic feet per acre per year, and for western hemlock at age 50 it is 256 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. The restricted rooting depth, caused by the seasonal high water table, occasionally causes windthrow.

Common forest understory species include salmonberry, western swordfern, red huckleberry, salal, and vine maple.

This map unit is in capability subclass IVe.

140-Swem gravelly silt loam, 30 to 65 percent slopes. This very deep, moderately well drained soil is on old earthflows. It formed in colluvium derived from basalt and deposited over marine sediment. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 500 to 1,400 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 1.5 inches thick. The surface layer is very dark brown gravelly silt loam about 15 inches thick. The upper 13 inches of the subsoil is mottled, yellowish brown gravelly silt loam, and the lower part to a depth of 60 inches or more is mottled, yellowish brown silt loam.

Included in this unit are about 15 percent Lytell soils and 10 percent Bunker and Zenker soils. Also included in some mapped areas is as much as 10 percent Swem soils that have slopes of less than 30 percent.

Permeability of this Swem soil is moderately slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 30 to 42 inches from November to March. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, bigleaf maple, and Sitka spruce. On the basis of a 100-year site curve, the mean site index is 163 for Douglas-fir and 161 for western hemlock. On the basis of a 50-year site curve, the mean site index is 125 for Douglas-fir and 114 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 173 cubic feet per acre per year, and for western hemlock at age 50 it is 256 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. The restricted rooting depth, caused by the seasonal high water table, occasionally causes windthrow.

Common forest understory species include salmonberry, western swordfern, red huckleberry, salal, and vine maple.

This map unit is in capability subclass VIe.

141-Sylvia silt loam. This very deep, moderately well drained soil is in old lakebeds. It formed in lacustrine silt and clay. The slope is 1 to 5 percent. The native vegetation is mainly conifers. Elevation is 20 to 200 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 3 inches thick. The surface layer is very dark grayish brown silt loam about 17 inches thick. The subsoil to a depth of 60 inches or more is mottled, dark yellowish brown and yellowish brown silty clay loam.

Included in this unit is about 5 percent Astoria, Lebam, Lytell, Hoquiam, and Palix soils. Also included in some mapped areas is as much as 10 percent Arta and Willapa soils.

Permeability of this Sylvia soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 18 to 36 inches from November to March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, western redcedar, and red alder. On the basis of a 100-year site curve, the mean site index for western hemlock is 168, and on the basis of a 50-year site curve, the mean site index is 120. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 270 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use

of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. The restricted rooting depth, caused by the high water table, occasionally causes windthrow.

Common forest understory species include western swordfern, vine maple, red huckleberry, salal, and devilsclub.

This map unit is in capability subclass IIIw.

142-Tebo silt loam, 5 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in glacial drift derived dominantly from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 52 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 3.5 inches thick. The upper 9 inches of the surface layer is dark reddish brown silt loam, and the lower 4 inches is dark reddish brown gravelly clay loam. The upper 35 inches of the subsoil is reddish brown and dark brown cobbly silty clay loam, the next 9 inches is dark yellowish brown cobbly clay loam, and the lower part to a depth of 60 inches or more is dark yellowish brown gravelly clay loam.

Included in this unit are about 10 percent Schneider soils and 10 percent Tebo soils that have slopes of more than 30 percent.

Permeability of this Tebo soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used as rural homesites.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 187, and on the basis of a 50-year site curve, the mean site index is 138. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 197 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit, generally at a depth of 5 to 10 feet. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily and by western hemlock it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, Oregon-grape, vine maple, western swordfern, and red huckleberry.

If this unit is used for homesite development, the main limitation is steepness of slope. Erosion is a hazard in the steeper areas, and excavation for roads and buildings increases the risk of erosion. The deep cuts needed to provide essentially level building sites can expose bedrock. Only the part of the site that is used for construction should be disturbed. Preserving the existing plant cover during construction helps to control erosion. Plant cover can be established and maintained through proper fertilizing, seeding, mulching, and shaping of the slopes.

Steepness of slope is a concern in installing septic tank absorption fields. Absorption lines should be installed on the contour.

Access roads should be designed to provide adequate cut-slope grade, and drains are needed to control surface runoff and keep soil losses to a minimum.

This map unit is in capability subclass IVe.

143-Tebo silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on uplands. It formed in glacial drift derived dominantly from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 200 to 800 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 52 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles and twigs about 3.5 inches thick. The upper 7 inches of the surface layer is dark reddish brown silt loam, and the lower 4 inches is dark reddish brown gravelly clay loam. The upper 35 inches of the subsoil is reddish brown and dark brown cobbly silty clay loam, the next 9 inches is dark yellowish brown cobbly clay loam, and the lower part to a depth of 60 inches or more is dark yellowish brown gravelly clay loam.

Included in this unit are about 10 percent Schneider soils and 10 percent Tebo soils that have slopes of less than 30 percent.

Permeability of this Tebo soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir is the principal forest species on this unit. Trees of limited extent include red alder, western hemlock, western redcedar, and bigleaf maple. On the basis of a 100-year site curve, the mean site index for Douglas-fir is 187, and on the basis of a 50-year site curve, the mean site index is 138. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 197 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rounded gravel and cobbles for road construction are readily available in areas of this unit, generally at a depth of 5 to 10 feet. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily and by western hemlock it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, Oregon-grape, vine maple, western swordfern, and red huckleberry.

This map unit is in capability subclass VIe.

144-Traham very gravelly loam, 5 to 30 percent slopes. This moderately deep, well drained soil is on narrow ridgetops, shoulders, and back slopes of uplands. It formed in colluvium and residuum derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 1,100 to 2,200 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and wood fragments about 4 inches thick. The surface layer is dark brown and dark reddish brown very gravelly loam about 15 inches thick. The subsoil is dark reddish brown and dark brown very gravelly clay loam about 21 inches thick. Fractured basalt is at a depth of about 36 inches. Depth to bedrock ranges from 24 to 36 inches.

Included in this unit are about 10 percent Knappton soils, 3 percent Vesta soils, and 2 percent Lates and Murnen soils. Also included in some mapped areas are as much as 5 percent Traham soils that have slopes of more than 30 percent and as much as 2 percent Rock outcrop.

Permeability of this Traham soil is moderate. Available water capacity is moderate. Effective rooting depth is 24 to 36 inches. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 135, and on the basis of a 50-year site curve, the mean site index is 92. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 209 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can delay natural regeneration of western hemlock and prevent establishment of Douglas-fir seedlings. The restricted rooting depth, caused by the underlying bedrock, occasionally causes windthrow.

Common forest understory species include salal, Oregon-grape, red huckleberry, western swordfern, and vine maple.

This map unit is in capability subclass IVe.

145-Traham very gravelly loam, 65 to 90 percent slopes. This moderately deep, well drained soil is on narrow ridgetops and back slopes of uplands. It formed in colluvium and residuum derived from basalt.

Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 1,100 to 2,200 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and wood fragments about 4 inches thick. The surface layer is dark brown and dark reddish brown very gravelly loam about 11 inches thick. The subsoil is dark reddish brown and dark brown very gravelly clay loam about 20 inches thick. Fractured basalt is at a depth of about 31 inches. Depth to bedrock ranges from 24 to 36 inches.

Included in this unit are about 10 percent Knappton soils, 5 percent Traham soils that have slopes of less than 65 percent, and 5 percent Rock outcrop.

Permeability of this Traham soil is moderate. Available water capacity is moderate. Effective rooting depth is 24 to 36 inches. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 135, and on the basis of a 50-year site curve, the mean site index is 92. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 209 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made inn the canopy, invading brushy plants can delay regeneration of western hemlock and prevent establishment of Douglas-fir seedlings. The restricted rooting depth, caused by the underlying bedrock, occasionally causes windthrow.

Common forest understory species include salal, Oregon-grape, red huckleberry, western swordfern, and vine maple.

This map unit is in capability subclass VIIe.

146-Udipsamments, level. These very deep, excessively drained soils are in depressional areas. They formed in gravelly sand. The slope is 0 to 2 percent. The native vegetation is sparse grasses and shrubs. Elevation is 10 to 30 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season (at 32 degrees) is 165 to 200 days.

No single profile is representative of these soils, but one commonly observed has a surface layer that is dark grayish brown sand about 6 inches thick. The underlying material to a depth of 60 inches or more is dark grayish brown sand and gravelly sand.

Included in this unit are some small areas of Udorthents, level.

Permeability of these Udipsamments, level, soils is rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is very slow, and water erosion is not a hazard. These soils are subject to rare flooding.

This unit is used as sites for homes or commercial buildings or as a source of fill material.

If this unit is used as sites for homes or commercial buildings, the main limitation is the hazard of rare flooding. Dikes need to be maintained to control flooding. In summer, irrigation is needed for lawn grasses, shrubs, vines, shade trees, and ornamental trees. Mulch, fertilizer, and irrigation are needed to establish lawn grasses. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems.

This map unit is in capability subclass VIs.

147-Udorthents, level. These very deep, moderately well drained, somewhat excessively drained, and excessively drained soils are on diked tidelands. They formed in sandy and loamy river dredgings. The slope is 0 to 2 percent. The native vegetation is annuals and shrubs. Elevation is sea level to 30 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season (at 32 degrees) is 150 to 200 days.

No single profile is representative of these soils, but one commonly observed has a surface layer that is dark grayish brown sandy loam about 6 inches thick. The underlying material to a depth of 60 inches or more is dark grayish brown sandy loam and loam. The underlying material has layers ranging in texture from sand to silt loam.

Included in this unit are some small areas of Udipsamments, level.

Permeability of these Udorthents, level, soils is moderately rapid. Available water capacity is low to moderate. Effective rooting depth is limited by a seasonal high water table that is at a depth of 2 to 6 feet from November through May. Runoff is slow, and the hazard of water erosion is slight. These soils are subject to rare flooding.

This unit is used for hay, pasture, industrial sites, and homesites.

If this unit is used for hay or pasture, the main limitations are the low soil fertility and the low available water capacity in some areas. In areas where the soils have low available water capacity, applications of irrigation water should be light and frequent. Sprinkler irrigation is a suitable method. Water should be applied in amounts sufficient to wet the root zone but small enough to minimize the leaching of plant nutrients. Restricting grazing during wet periods helps to maintain the condition of the pasture and soils.

If this unit is used as industrial sites and homesites, the main limitation is the hazard of rare flooding. Dikes need to be maintained to control flooding. Disturbed areas of the unit should be allowed to settle for a year before buildings are constructed.

This map unit is in capability subclass IVs.

148-Umbric Dystrochrepts, very steep. These moderately deep to very deep, well drained soils are on bluffs along the Columbia River, on mountains, and in gullies and canyons. They formed in material derived from basalt. The slope is 85 to 100 percent. The soils are mainly on south-facing slopes. The native vegetation is mainly conifers. Elevation is 200 to 1,800 feet. The average annual precipitation is 60 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

No single profile is representative of these soils, but one commonly observed has a mat of undecomposed needles and twigs about 1 inch thick on the surface. The surface layer is very dark grayish brown gravelly sandy loam about 8 inches thick. The subsoil to a depth of 60 inches or more is brown, dark brown, and dark reddish brown gravelly clay loam and gravelly loam. Depth to bedrock ranges from 20 to 60 inches or more. In some areas the subsoil is cobbly clay loam or cobbly loam.

Included in this unit is about 10 percent Boistfort, Bunker, and Raught soils. Also included in some mapped areas are as much as 10 percent Katula soils and 20 percent Rock outcrop and very stony soils.

Permeability of these Umbric Dystrochrepts soils is moderate. Available water capacity is low to high. Effective rooting depth is limited by bedrock at a depth of 20 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as wildlife habitat and woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, bigleaf maple, and Pacific madrone. On the basis of a 100-year site curve, the estimated mean site index is 144 for Douglas-fir and 141 for western hemlock. On the basis of a 50-year site curve, the estimated mean site index is 110 for Douglas-fir and 100 for western hemlock. Site index and growth for all species are variable on this unit. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 150 cubic feet per acre per year, and for western hemlock at age 50 it is 220 cubic feet per acre per year. The included areas of Rock outcrop and very stony soils limit yields.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. Logging roads can be constructed on the more nearly level included areas in this unit. They require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff; however, the included areas of Rock outcrop limit the use of these systems.

Seedling mortality is the main concern in producing timber. Reforestation in most areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by red alder occurs readily and by western hemlock it occurs periodically. Droughtiness of the surface layer increases seedling mortality. In areas of soils that have bedrock at a depth of 20 to 40 inches, trees are occasionally subject to windthrow when winds are moderate to strong and the soils are wet. Storms and high winds on the Columbia River bluffs occasionally cause breakage and branch damage. If openings are made in the canopy, invading brushy plants can delay establishment of Douglas-fir seedlings and natural regeneration of western hemlock.

Common forest understory species include salal, Oregon-grape, red huckleberry, western swordfern, and western brackenfern.

This map unit is in capability subclass VIIe.

149-Vesta silt loam, 1 to 8 percent slopes. This very deep, well drained soil is on ridgetops of uplands. It formed in material derived from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The surface layer is dark reddish brown silt loam about 15 inches thick. The upper 24 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is strong brown silty clay.

Included in this unit are about 5 percent Knappton soils and 2 percent Lebam, Ilwaco, and Traham soils. Also included in some mapped areas is as much as 5 percent Vesta soils that have slopes of more than 8 percent.

Permeability of this Vesta soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used as rural homesites.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 158, and on the basis of a 50-year site curve, the mean site index is 112. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 251 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. Seedling mortality is higher in areas of this unit on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay regeneration of western hemlock.

Common forest understory species include salmonberry, red elderberry, red huckleberry, western swordfern, and western brackenfern.

This unit is well suited to homesite development. If the unit is used for septic tank absorption fields, the limitation of moderate permeability can be overcome by increasing the size of the absorption field.

This map unit is in capability subclass IIIe.

150-Vesta silt loam, 8 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The surface layer is dark reddish brown silt loam about 13 inches thick. The upper 24 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is strong brown silty clay.

Included in this unit are about 5 percent Knappton soils and 2 percent Lebam, Ilwaco, and Traham soils. Also included in some mapped areas is as much as 5 percent Vesta soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Vesta soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 158, and on the basis of a 50-year site curve, the mean site index is 112. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 251 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, .soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. Seedling mortality is higher in areas of this unit on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir

seedlings and can delay regeneration of western hemlock.

Common forest understory species include salmonberry, red elderberry, red huckleberry, western swordfern, and western brackenfern.

This map unit is in capability subclass IVe.

151-Vesta silt loam, 30 to 65 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The surface layer is dark reddish brown silt loam about 11 inches thick. The upper 28 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is strong brown silty clay.

Included in this unit are about 5 percent Knappton and Traham soils and 2 percent Lates and Murnen soils. Also included in some mapped areas is as much as 5 percent Vesta soils that have slopes of less than 30 percent.

Permeability of this Vesta soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Douglas-fir, red alder, Sitka spruce, and western redcedar. On the basis of a 100-year site curve, the mean site index for western hemlock is 158, and on the basis of a 50-year site curve, the mean site index is 112. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 251 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. Seedling mortality is higher in areas of this unit on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salmonberry, red elderberry, red huckleberry, western swordfern, and western brackenfern.

This map unit is in capability subclass VIe.

152-Vesta silt loam, cool, 5 to 30 percent slopes. This very deep, well drained soil is on uplands. It formed in material derived from basalt. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 100 to 1,800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles, twigs, and moss about 1 inch thick. The surface layer is dark reddish brown silt loam about 15 inches thick. The upper 21 inches of the subsoil is dark brown silty clay loam, and the lower part to a depth of 60 inches or more is strong brown silty clay.

Included in this unit is about 15 percent Lebam, cool, soils; Ilwaco, cool, soils; and Newskah soils.

Permeability of this Vesta soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is 145, and on the basis of a 50-year site curve, the mean site index is 104. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 228 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is readily available in areas of this unit, generally at a depth of 5 to 10 feet. Steep cuts and fills erode readily unless a plant cover is established. Careful use of

wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. Seedling mortality is higher in areas of this unit on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce.

Common forest understory species include salmonberry, red elderberry, red huckleberry, western swordfern, and western brackenfern.

This map unit is in capability subclass IVe.

153-Westport fine sand, 3 to 10 percent slopes. This very deep, excessively drained soil is on long, narrow, stabilized sand dunes. It formed in slightly weathered dune sand. The native vegetation is mainly grass and shore pine. Elevation is 10 to 50 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a thin mat of grass, moss, leaves, and needles. The surface layer is very dark grayish brown fine sand about 7 inches thick. The upper 9 inches of the underlying material is dark grayish brown fine sand, and the lower part to a depth of 60 inches or more is olive gray fine sand.

Included in this unit are about 5 percent Yaquina soils and 1 percent Seastrand soils. Also included in some mapped areas are as much as 5 percent Netarts soils and 5 percent Dune land.

Permeability of this Westport soil is very rapid. Available water capacity is low. Effective rooting depth generally is 60 inches or more, but it may be restricted by a lack of moisture and nutrients. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe.

This unit is used as sites for homes and commercial buildings.

This unit is well suited to homesite development. If the density of housing is moderate to high, community sewage systems are needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Revegetating disturbed areas around construction sites as soon as possible helps to control soil blowing.

This map unit is in capability subclass VIe.

154-Willaby silt loam, 1 to 15 percent slopes. This very deep, moderately well drained soil is on terraces. It formed in piedmont glacial drift. The native vegetation is mainly conifers. Elevation is 100 to 500 feet. The average annual precipitation is 110 to 150 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaves, needles, twigs, and moss about 2.5 inches thick. The surface layer is dark reddish brown and dark brown silt loam about 11 inches thick. The upper 14 inches of the subsoil is strong brown silty clay, and the lower 22 inches is yellowish brown very gravelly silty clay. The substratum to a depth of 60 inches or more is yellowish brown extremely gravelly silty clay loam.

Included in this unit are about 10 percent Halbert soils and 5 percent Nemah soils. Also included in some mapped areas is as much as 10 percent Nordby and O'Brien soils.

Permeability of this Willaby soil is moderately slow. Available water capacity is moderate. Effective rooting depth is limited by a seasonal high water table that is at a depth of 24 to 36 inches from November to March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder and western redcedar. On the basis of a 100-year site curve, the mean site index is 166 for Douglas-fir and 153 for western hemlock. On the basis of a 50-year site curve, the mean site index is 125 for Douglas-fir and 110 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 177 cubic feet per acre per year, and for western hemlock at age 50 it is 243 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. The restricted rooting depth, caused by the seasonal high water table, occasionally causes windthrow.

Common forest understory species include salal, blue huckleberry, western swordfern, western brackenfern, and deer fern.

This map unit is in capability subclass IIIe.

155-Willapa silt loam, 1 to 8 percent slopes. This very deep, moderately well drained soil is on broad, wave-cut marine terraces. It formed in medium- and fine-textured marine sediment. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs about 1 inch thick. The surface layer is dark brown silt loam about 18 inches thick. The subsoil is mottled, dark yellowish brown silty clay loam about 25 inches thick. The substratum to a depth of 60 inches or more is mottled, pale brown silty clay loam. In some areas the substratum has sandy strata.

Included in this unit are about 2 percent Nemah soils, 5 percent Lebam and Ilwaco soils, and 2 percent Vesta soils. Also included in some mapped areas is as much as 10 percent Willapa soils that have slopes of more than 8 percent.

Permeability of this Willapa soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 30 to 42 inches from November to March. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used as rural homesites.

Western hemlock is the principal forest species on this unit. Trees of limited extent include western redcedar, Sitka spruce, red alder, and Douglas-fir. On the basis of a 100-year site curve, the mean site index is 158 for western hemlock and 170 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 113 for western hemlock and 125 for Douglas-fir. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 251 cubic feet per acre per year, and for Douglas-fir at age 60 it is 181 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. The restricted rooting depth, caused by the seasonal high water table, occasionally causes windthrow.

Common forest understory species include salmonberry, salal, red huckleberry, red elderberry, and western swordfern.

This unit is well suited to homesite development. Septic tank absorption fields do not function properly because of wetness.

This map unit is in capability subclass IIIe.

156-Willapa silt loam, 8 to 30 percent slopes. This very deep, moderately well drained soil is on wave-cut marine terraces. It formed in medium- and fine-textured marine sediment. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs about 1 inch thick. The surface layer is dark brown silt loam about 20 inches thick. The subsoil is mottled, dark yellowish brown silty clay loam about 23 inches thick. The substratum to a depth of 60 inches or more is mottled, pale brown silty clay loam. In some areas the substratum has sandy strata.

Included in this unit are about 5 percent Lebam, Ilwaco, and Palix soils and 2 percent Vesta and Narel soils. Also included in some mapped areas is as much as 10 percent Willapa soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Willapa soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 30 to 42 inches from November to March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include western redcedar, Sitka spruce, red alder, and Douglas-fir. On the basis of a 100-year site curve, the mean site index is 158 for western hemlock and 170 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 113 for western hemlock and 125 for Douglas-fir. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 251 cubic feet

per acre per year, and for Douglas-fir at age 60 it is 181 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. The restricted rooting depth, caused by the seasonal high water table, occasionally causes windthrow.

Common forest understory species include salmonberry, salal, red huckleberry, red elderberry, and western swordfern.

This map unit is in capability subclass IVe.

157-Willapa silt loam, 30 to 70 percent slopes. This very deep, moderately well drained soil is on back slopes of wave-cut marine terraces. It formed in medium- and fine-textured marine sediment. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of needles, leaves, and twigs about 1 inch thick. The surface layer is dark brown silt loam about 15 inches thick. The subsoil is mottled, dark yellowish brown silty clay loam about 22 inches thick. The substratum to a depth of 60 inches or more is mottled, pale brown silty clay loam. In some areas the substratum has sandy strata.

Included in this unit are about 5 percent Palix, Newskah, and Narel soils and 2 percent Vesta soils. Also included in some mapped areas is as much as 10 percent Willapa soils that have slopes of less than 30 percent.

Permeability of this Willapa soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 30 to 42 inches from November to March. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include western redcedar, Sitka spruce, red alder, and Douglas-fir. On the basis of a 100-year site curve, the mean site index is 158 for western hemlock and 170 for Douglas-fir. On the basis of a 50-year site curve, the mean site index is 113 for western hemlock and 125 for Douglas-fir. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is 251 cubic feet per acre per year, and for Douglas-fir at age 60 it is 181 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock. The restricted rooting depth, caused by the seasonal high water table, occasionally causes windthrow.

Common forest understory species include salmonberry, salal, red huckleberry, red elderberry, and western swordfern.

This map unit is in capability subclass VIe.

158-Willapa silt loam, cool, 1 to 8 percent slopes. This very deep, moderately well drained soil is on broad, wave-cut marine terraces. It formed in medium- and fine-textured marine sediment. Drainageways generally are more than 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles, leaves, and twigs about 1 inch thick. The surface layer is dark brown silt loam about 18 inches thick. The subsoil is mottled, dark yellowish brown silty clay loam about 25 inches thick. The substratum to a depth of 60 inches or more is mottled, pale brown silty clay loam. In some areas the substratum has sandy strata.

Included in this unit are about 2 percent Nemah soils; 5 percent Lebam, cool, soils; Newskah soils; and Ilwaco, cool, soils; and 2 percent Vesta, cool, soils. Also included in some mapped areas is as much as 10 percent Willapa, cool, soils that have slopes of more than 8 percent.

Permeability of this Willapa soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 30 to 42 inches from November to March. Runoff is slow, and the hazard of water erosion is slight.

Most areas of this unit are used as woodland. Some areas are used as rural homesites.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index is about 147 for western hemlock. On the basis of a 50-year site curve, the mean site index is about 105 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 232 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce. The restricted rooting depth, caused by the seasonal high water table and the strong coastal winds, causes occasional windthrow.

Common forest understory species include salmonberry, salal, red huckleberry, red elderberry, and western swordfern.

This unit is well suited to homesite development. Septic tank absorption fields, however, do not function properly because of wetness.

This map unit is in capability subclass IVe.

159-Willapa silt loam, cool, 8 to 30 percent slopes. This very deep, moderately well drained soil is on wave-cut marine terraces. It formed in medium- and fine-textured marine sediment. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles, leaves, and twigs about 1 inch thick. The surface layer is dark brown silt loam about 20 inches thick. The subsoil is mottled, dark yellowish brown silty clay loam about 23 inches thick. The substratum to a depth of 60 inches or more is mottled, pale brown silty clay loam. In some areas the substratum has sandy strata.

Included in this unit are about 5 percent Lebam, cool, soils; Ilwaco, cool, soils; and Palix, cool, soils and 2 percent Vesta, cool, soils. Also included in some mapped areas is as much as 10 percent Willapa, cool, soils that have slopes of less than 8 percent or more than 30 percent.

Permeability of this Willapa soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 30 to 42 inches from November to March. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is about 147, and on the basis of a 50-year site curve, the mean site index is about 105. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 232 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce. The restricted rooting depth, caused by the seasonal high

water table and the strong coastal winds, causes occasional windthrow.

Common forest understory species include salmonberry, salal, red huckleberry, red elderberry, and western swordfern.

This map unit is in capability subclass IVe.

160-Willapa silt loam, cool, 30 to 70 percent slopes. This very deep, moderately well drained soil is on back slopes of wave-cut marine terraces. It formed in medium- and fine-textured marine sediment. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 46 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days. This soil is subject to strong coastal winds and prolonged seasonal fog cover.

Typically, the surface is covered with a mat of needles, leaves, and twigs about 1 inch thick. The surface layer is dark brown silt loam about 20 inches thick. The subsoil is mottled, dark yellowish brown silty clay loam about 23 inches thick. The substratum to a depth of 60 inches or more is mottled, pale brown silty clay loam. In some areas the substratum has sandy strata.

Included in this unit is about 15 percent Palix, cool, soils and Newskah soils. Also included in some mapped areas is as much as 10 percent Willapa, cool, soils that have slopes of less than 30 percent.

Permeability of this Willapa soil is moderate. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 30 to 42 inches from November to March. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Western hemlock is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western redcedar, red alder, and Pacific silver fir. On the basis of a 100-year site curve, the mean site index for western hemlock is about 147, and on the basis of a 50-year site curve, the mean site index is about 105. Yield tables indicate that the mean annual increment at culmination (CMAI) for western hemlock at age 50 is about 232 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western hemlock and Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily and by Sitka spruce it occurs periodically. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay reforestation by western hemlock and Sitka spruce. The restricted rooting depth, caused by the seasonal high water table and the strong coastal winds, causes occasional windthrow.

Common forest understory species include salmonberry, salal, red huckleberry, red elderberry, and western swordfern.

This map unit is in capability subclass VIe.

161-Wishkah silty clay loam. This very deep, somewhat poorly drained soil is on old alluvial terraces of glacial outwash plains. Drainage has been altered by ditching and tiling. The soil formed in glacial lacustrine sediment. The slope is 0 to 2 percent. The native vegetation is mainly conifers and hardwoods. Elevation is 50 to 500 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season (at 28 degrees) is 180 to 220 days.

Typically, the surface is covered with a mat of partially decomposed needles, twigs, and wood about 5 inches thick. The surface layer is very dark grayish brown silty clay loam about 6 inches thick. The upper 4 inches of the subsoil is mottled, dark yellowish brown silty clay, and the lower 29 inches is mottled, yellowish brown and grayish brown clay. The substratum to a depth of 60 inches or more is mottled, light olive gray clay. In some areas the substratum is as much as 50 percent gravel.

Included in this unit are about 5 percent Nemah soils and 5 percent Aabab soils. Also included is about 30 percent Wishkah soils that are not drained.

Permeability of this Wishkah soil is slow. Available water capacity is high. Effective rooting depth is limited by a seasonal high water table that is at a depth of 30 to 42 inches from November to April. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for hay and pasture. It is also used as woodland.

This unit is well suited to hay and pasture. The main limitation is the soil wetness. Restricting grazing during wet periods helps to maintain the condition of the pasture and soil.

Western hemlock and red alder are the principal forest species. Trees of limited extent include western redcedar and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 155 for western hemlock. On the basis of a 50-year site curve, the mean site index is 110 for western hemlock and 85 for red alder. Yield tables indicate that the mean annual increment at culmination

(CMAI) for western hemlock at age 50 is 246 cubic feet per acre per year, and for red alder at age 40 it is 92 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads and skid trails are soft and sticky and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. The seasonal high water table restricts the use of equipment to the dry summer months. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western redcedar seedlings. If seed trees are present, natural reforestation by red alder occurs readily and by western hemlock it occurs periodically. The seasonal high water table reduces root respiration and causes seedling mortality. If openings are made in the canopy, invading brushy plants can delay establishment of planted western redcedar and can delay reforestation by western hemlock. The restricted rooting depth, caused by the high water table, frequently causes windthrow.

Common forest understory species include salmonberry, devilsclub, vine maple, skunkcabbage, and cascara buckthorn.

This map unit is in capability subclass IIIw.

162-Yaquina loamy fine sand. This very deep, somewhat poorly drained soil is in depressional areas between stabilized sand dunes. It formed in slightly weathered beach and dune sand. The slope is 0 to 1 percent. The native vegetation is mainly conifers and hardwoods. Elevation is 10 to 50 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of needles, twigs, and leaves about 0.5 inch thick. The surface layer is very dark grayish brown and dark reddish gray loamy fine sand about 9 inches thick. The subsoil is dark reddish gray and dark brown fine sand about 15 inches thick. The substratum to a depth of 60 inches or more is olive brown fine sand. In some areas the subsoil has thin, weakly cemented strata.

Included in this unit are about 2 percent Netarts soils and 2 percent Westport soils. Also included in some mapped areas are as much as 5 percent Seastrand soils and as much as 2 percent Orcas and Seastrand Variant soils.

Permeability of this Yaquina soil is moderately rapid. Available water capacity is low. Effective rooting depth is limited by a seasonal high water table that ranges from a depth of 24 inches to the surface from November to April. Runoff is very slow, and water erosion is not a hazard.

Most areas of this unit are used as woodland. Some areas are used for pasture.

Red alder is the principal forest species on this unit. Trees of limited extent include Sitka spruce, western hemlock, western redcedar, and shore pine. On the basis of a 50-year site curve, the mean site index is 90 for red alder. Yield tables indicate that the mean annual increment at culmination (CMAI) for red alder at age 40 is 101 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. The seasonal high water table restricts the use of equipment to the dry summer months. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling mortality is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting western redcedar and Sitka spruce seedlings. If seed trees are present, natural reforestation by red alder occurs readily. The seasonal high water table reduces root respiration and causes seedling mortality. If openings are made in the canopy, invading brushy plants can delay establishment of planted seedlings. The restricted rooting depth, caused by the seasonal high water table, frequently causes windthrow.

Common forest understory species include salmonberry, sedges, salal, cascara buckthorn, and skunkcabbage.

If this unit is used for pasture, the main limitation is the seasonal high water table. The water table can be lowered by installing tile drains or open ditches if adequate outlets are available.

This map unit is in capability subclass IVw.

163-Zenker silt loam, 8 to 30 percent slopes. This very deep, well drained soil is on foot slopes and shoulders of uplands. It formed in colluvium derived from moderately hard sandstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 1,600 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark brown silt loam about 11 inches thick. The upper 6 inches of the subsoil

is very dark grayish brown silt loam, and the lower part to a depth of 60 inches or more is dark brown loam.

Included in this unit are about 10 percent Elochoman soils and 5 percent Lytell and Astoria soils. Also included in some mapped areas is as much as 10 percent Zenker soils that have slopes of more than 30 percent.

Permeability of this Zenker soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, Sitka spruce, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 175 for Douglas-fir and 171 for western hemlock. On the basis of a 50-year site curve, the mean site index is 133 for Douglas-fir and 122 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 186 cubic feet per acre per year, and for western hemlock at age 50 it is 276 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, Oregon-grape, western swordfern, and western brackenfern.

This map unit is in capability subclass IVe.

164-Zenker silt loam, 30 to 65 percent slopes. This **very** deep, well drained soil is on back slopes of uplands. It formed in colluvium derived from moderately hard sandstone. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 1,600 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark brown silt loam about 9 inches thick. The upper 7 inches of the subsoil is very dark grayish brown silt loam, and the lower part to a depth of 60 inches or more is dark brown loam.

Included in this unit are about 10 percent Elochoman soils and 5 percent Lytell and Astoria soils. Also included in some mapped areas is as much as 10 percent Zenker soils that have slopes of less than 30 percent or more than 65 percent.

Permeability of this Zenker soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, Sitka spruce, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 175 for Douglas-fir and 171 for western hemlock. On the basis of a 50-year site curve, the mean site index is 133 for Douglas-fir and 122 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 186 cubic feet per acre per year, and for western hemlock at age 50 it is 276 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, Oregon-grape, western swordfern, and western brackenfern.

This map unit is in capability subclass VIe.

165-Zenker silt loam, 65 to 90 percent slopes. This very deep, well drained soil is on back slopes of uplands. It formed in colluvium derived from moderately hard sandstone. Drainageways generally are less than

1,000 feet apart. The native vegetation is mainly conifers. Elevation is 50 to 1,600 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface layer is very dark brown silt loam about 6 inches thick. The upper 9 inches of the subsoil is very dark grayish brown silt loam, and the lower part to a depth of 60 inches or more is dark brown loam.

Included in this unit is about 5 percent Lytell soils. Also included in some mapped areas is as much as 10 percent Elochoman soils and Zenker soils that have slopes of less than 65 percent.

Permeability of this Zenker soil is moderate. Available water capacity is high. Effective rooting depth is 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include red alder, western redcedar, Sitka spruce, and bigleaf maple. On the basis of a 100-year site curve, the mean site index is 162 for Douglas-fir and 171 for western hemlock. On the basis of a 50-year site curve, the mean site index is 127 for Douglas-fir and 122 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 65 is 172 cubic feet per acre per year, and for western hemlock at age 50 it is 276 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock and red alder occurs readily. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include salal, salmonberry, Oregon-grape, western swordfern, and western brackenfern.

This map unit is in capability subclass VIIe.

166-Zyzyl gravelly loam, 8 to 30 percent slopes. This deep, well drained soil is on ridgetops of mountains. It formed in residuum and colluvium derived from highly chloritized Eocene marine basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 600 to 1,800 feet. The average annual precipitation is 120 to 180 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaves, twigs, and partially decomposed wood about 2 inches thick. The surface layer is dark brown gravelly loam about 9 inches thick. The upper 11 inches of the subsoil is dark brown gravelly loam, and the lower 19 inches is dark reddish brown gravelly sandy loam. The substratum is reddish brown gravelly sandy loam about 6 inches thick. Highly fractured, loose, chloritized basalt is at a depth of about 45 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 5 percent Lytell soils and 10 percent Nordby and Copalis soils. Also included in some mapped areas are as much as 10 percent Zyzyl soils that have slopes of more than 30 percent and 5 percent soils that are less than 60 inches deep to consolidated bedrock.

Permeability of this Zyzyl soil is moderate. Available water capacity is moderate. Effective rooting depth is 40 to 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include western redcedar and Sitka spruce. On the basis of a 100-year site curve, the mean site index is 156 for Douglas-fir and 158 for western hemlock. On the basis of a 50-year site curve, the mean site index is 118 for Douglas-fir and 111 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 165 cubic feet per acre per year, and for western hemlock at age 50 it is 251 cubic feet per acre per year.

The main limitation for harvesting timber is muddiness when the soil is wet. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Careful use of wheeled or tracked equipment reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western

hemlock occurs readily. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include Oregon-grape, vine maple, salmonberry, western swordfern, and western brackenfern.

This map unit is in capability subclass IVe.

167-Zyzyl gravelly loam, 30 to 65 percent slopes. This deep, well drained soil is on back slopes of mountains. It formed in residuum and colluvium derived from highly chloritized Eocene marine basalt. Drainageways generally are 1,000 to 1,500 feet apart. The native vegetation is mainly conifers. Elevation is 600 to 1,800 feet. The average annual precipitation is 120 to 180 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaves, twigs, and partially decomposed wood about 2 inches thick. The surface layer is dark brown gravelly loam about 10 inches thick. The upper 12 inches of the subsoil is dark brown gravelly loam, and the lower 15 inches is dark reddish brown gravelly sandy loam. The substratum is reddish brown gravelly sandy loam about 10 inches thick. Highly fractured, loose, chloritized basalt is at a depth of about 47 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 5 percent Lytell soils and 5 percent Nordby and Copalis soils. Also included in some mapped areas are as much as 15 percent Zyzyl soils that have slopes of less than 30 percent or more than 65 percent and 10 percent soils that are less than 60 inches deep to consolidated bedrock.

Permeability of this Zyzyl soil is moderate. Available water capacity is moderate. Effective rooting depth is 40 to 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include western redcedar and Sitka spruce. On the basis of a 100-year site curve, the mean site index is 156 for Douglas-fir and 158 for western hemlock. On the basis of a 50-year site curve, the mean site index is 118 for Douglas-fir and 111 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 165 cubic feet per acre per year, and for western hemlock at age 50 it is 251 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Slope limits the use of wheeled or tracked equipment during harvesting; cable yarding systems are safer and disturb the soil less. Using wheeled or tracked equipment when the soil is wet causes ruts, soil compaction, and damage to tree roots. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and can delay natural regeneration of western hemlock.

Common forest understory species include Oregon-grape, vine maple, salmonberry, western swordfern, and western brackenfern.

This map unit is in capability subclass VIe.

168-Zyzyl gravelly loam, 65 to 90 percent slopes. This deep, well drained soil is on back slopes of mountains. It formed in residuum and colluvium derived from highly chloritized marine basalt. Drainageways generally are less than 1,000 feet apart. The native vegetation is mainly conifers. Elevation is 600 to 1,800 feet. The average annual precipitation is 120 to 180 inches, the average annual air temperature is about 50 degrees F, and the average growing season (at 28 degrees) is 200 to 240 days.

Typically, the surface is covered with a mat of leaves, twigs, and partially decomposed wood about 2 inches thick. The surface layer is dark brown gravelly loam about 7 inches thick. The upper 9 inches of the subsoil is dark brown gravelly loam, and the lower 13 inches is dark reddish brown gravelly sandy loam. The substratum is reddish brown gravelly sandy loam about 16 inches thick. Highly fractured, loose, chloritized basalt is at a depth of about 45 inches. Depth to weathered bedrock ranges from 40 to 60 inches or more.

Included in this unit are about 2 percent Lytell soils and 15 percent Zyzyl soils that have slopes of less than 65 percent. Also included in some mapped areas is as much as 20 percent soils that are less than 60 inches deep to consolidated bedrock.

Permeability of this Zyzyl soil is moderate. Available water capacity is moderate. Effective rooting depth is 40 to 60 inches or more. Runoff is rapid, and the hazard of water erosion is severe.

This unit is used as woodland.

Douglas-fir and western hemlock are the principal forest species on this unit. Trees of limited extent include western redcedar and Sitka spruce. On the basis of a 100-year site curve, the mean site index is 156 for Douglas-fir and 158 for western hemlock. On the basis of a 50-year site curve, the mean site index is 118 for Douglas-fir and 111 for western hemlock. Yield tables indicate that the mean annual increment at culmination (CMAI) for Douglas-fir at age 60 is 165 cubic feet per acre per year, and for western hemlock at age 50 it is 251 cubic feet per acre per year.

The main limitation for harvesting timber is steepness of slope. Cable yarding systems generally are used. When wet, unsurfaced roads are soft and generally are impassable. Logging roads require suitable surfacing for year-round use. Rock for road construction is not readily available in areas of this unit. Steep cuts and fills erode readily unless a plant cover is established. Slumping and road failures can occur in clear-cut areas. Steep yarding paths, skid trails, and firebreaks are subject to rilling and gullying unless they are adequately protected by water bars or vegetation. Use of harvesting systems that lift logs entirely off the ground reduces disturbance of the protective layer of duff.

Seedling establishment is the main concern in producing timber. Reforestation in cutover areas can be accomplished by hand planting Douglas-fir seedlings. If seed trees are present, natural reforestation by western hemlock occurs readily. Seedling mortality is higher on ridgetops, which are subject to strong, persistent winds. Areas on ridgetops are less productive than other areas of the unit. If openings are made in the canopy, invading brushy plants can prevent establishment of Douglas-fir seedlings and. can delay natural regeneration of western hemlock.

Common forest understory species include Oregon-grape, vine maple, salmonberry, western swordfern, and western brackenfern.

This map unit is in capability subclass VIIe.

Prime Farmland

In this section, prime farmland is defined and discussed and the prime farmland soils in the survey area are listed.

Prime farmland is of major importance in providing the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. Adequate moisture and a sufficiently long growing season are required. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils either are used for producing food or fiber or are available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils have an adequate and dependable supply of moisture from precipitation or irrigation. Temperature and growing season are favorable, and the level of acidity or alkalinity is acceptable. The soils have few, if any, rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not flooded during the growing season. The slope ranges mainly from 0 to 8 percent.

Soils that have a high water table, are subject to flooding, or are droughty may qualify as prime farmland soils if the limitations are overcome by drainage, flood control, or irrigation. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

About 230,000 acres, or about 14 percent of the survey area, meets the requirements for prime farmland. Areas of prime farmland are scattered throughout the survey area, but most are in general soil map units 1, 2, and 3. About 80,000 acres of this is used for crops. These crops are used mainly as roughage for the beef and dairy cattle. Some crops are sold commercially. These include sweet corn and peas, which are used by the frozen food industry, cranberries, flower bulbs, and some potatoes.

Another 60,000 acres, or about 4 percent of the survey area, meets the requirements for prime farmland but is limited by a high water table or by susceptibility to flooding.

A recent trend in land use has been the conversion of prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on lands that are less productive than prime farmland.

The detailed soil map units that make up the prime farmland in the survey area are listed in this section. On some soils included in the list, appropriate measures have been applied to overcome a hazard or limitation such as flooding or wetness. This list does not constitute a recommendation for a particular land use. The extent of each map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this survey. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units."

1 Aabab silt loam (where drained)
2 Arta silt loam, 0 to 3 percent slopes
5 Astoria silt loam, 3 to 8 percent slopes
9 Bear Prairie silt loam, 0 to 3 percent slopes
10 Boistfort silt loam, 1 to 8 percent slopes
19 Calawah silt loam, 1 to 8 percent slopes
24 Cathlamet silt loam, 1 to 8 percent slopes
27 Centralia loam, 1 to 8 percent slopes
30 Chehalis silt loam
31 Cloquato silt loam
32 Copalis silt loam, 1 to 8 percent slopes
36 Elochoman silt loam, 1 to 8 percent slopes
40 Germany silt loam, 1 to 8 percent slopes
43 Grehalem silt loam 45 Hoquiam silt loam, 1 to 8 percent slopes
48 Humptulips silt loam (where protected from flooding)
49 Ilwaco silt loam, 1 to 8 percent slopes
65 Lebam silt loam, 1 to 8 percent slopes
68 Le Bar silt loam, 1 to 8 percent slopes
76 Melbourne silt loam, 1 to 8 percent slopes

79 Montesa silt loam, 1 to 8 percent slopes (where drained)
91 Nemah silty clay loam (where drained)
93 Newberg silt loam
94 Newskah loam, 1 to 8 percent slopes
101 Norma sandy loam (where drained)
102 Nuby silt loam
104 Ocosta silty clay loam
105 Olympic clay loam, 1 to 8 percent slopes
117 Papac gravelly silt loam, 1 to 8 percent slopes
125 Rennie silty clay loam (where drained and protected from flooding)
127 Salzer silty clay (where drained and protected from flooding)
128 Satsop silt loam, 1 to 8 percent slopes
129 Sauvie silt loam
134 Skamo silt loam, 0 to 8 percent slopes
138 Stimson silt loam (where drained)
141 Sylvia silt loam (where drained)
149 Vesta silt loam, 1 to 8 percent slopes
155 Willapa silt loam, 1 to 8 percent slopes
161 Wishkah silty clay loam

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

More than 79,895 acres in the survey area was used for crops and pasture in 1967 (30). Of this total, 3,053 acres was used for row crops, mainly crops for silage; 1,123 acres for close-growing crops, mainly wheat and oats; 1,130 acres for cranberries; 70,4077acres for rotation hay and pasture (fig. 20); and the rest as idle cropland.

The acreage in crops and pasture is gradually decreasing as more and more land is being used for urban development. In 1967 about 37,493 acres of urban and built-up land was in the survey area. The use of this soil survey to help make land use decisions that will influence the future role of farming in the area is discussed in the section "Broad Land Use Considerations."

Soil drainage is a major management need on about 26 percent of the acreage used for crops and pasture in the survey area. Some soils are too wet for crops commonly grown in the area. These are the poorly drained Nemah and Rennie soils and the very poorly drained Salzer soils, which make up about 29,000 acres of the survey area, and the organic Orcas, Seastrand, and Seastrand Variant soils, which make up about 9,100 acres.

Unless artificially drained, the somewhat poorly drained Aabab soils, which total about 6,140 acres, are so wet that crops are damaged during most years.

The preferred design of both surface and subsurface drainage systems varies with the kind of soil. For crops and pasture, a combination of surface drainage and subsurface tile drainage is needed in most areas of the poorly drained and very poorly drained soils. Drains have to be more closely spaced in the slowly permeable soils than in the more rapidly permeable ones. Finding adequate outlets for tile drainage systems is difficult in many areas.

Organic soils oxidize and subside when the pore space is filled with air; therefore, they require special drainage (9). Keeping the water table at the level required by crops during the growing season and raising it to the surface during other parts of the year minimize

Figure 20.-Hay and pasture on Cathlamet silt loam, 1 to 8 percent slopes, in foreground. Douglas-fir on Germany silt loam, 8 to 30 percent slopes, in background. These soils are in Wahkiakum County.

the oxidation and subsidence of organic soils such as the Seastrand and Seastrand Variant soils. In areas where cranberries are grown, a thin layer of sand is spread over the bog to reduce oxidation. Information on drainage design for each kind of soil is available at the local office of the Soil Conservation Service.

The moderately well drained and well drained soils on the uplands and old terraces in the survey area formed under coniferous forests, are moderately acid and are strongly leached of plant nutrients. The carbon-to-nitrogen ratio for the newly cleared lands is relatively wide, and only small quantities of nitrogen are made available to crops from the soil. Investigations indicate that cropping over a period of years increases the organic matter content and narrows the carbon-to nitrogen ratio, thus making more nitrogen available for crops (36). On these soils the prime requisite for good crop production is the addition of organic matter and nitrogen, which are best supplied and maintained by using legumes and crop rotations, plowing under green manure crops, and adding all available barnyard manure. The cost of commercial nitrogen fertilizer may limit its use unless the fertilizer is applied only to the more intensively grown cash crops. Phosphorus generally is beneficial, and barnyard manure is a good source of it.

The soils on the younger terraces and alluvial fans in the area have been subjected to less weathering and leaching than have the soils on the uplands and old terraces and generally are less acid and higher in natural fertility. Nevertheless, the deficiency in nutrients and the

response of crops to soil management generally are similar to those already discussed for the soils on uplands and old terraces. Arta, Bear Prairie, Montesa, Satsop, Skamo, and Willapa soils are on the younger terraces and alluvial fans.

The soils on the alluvial flood plains in the area are only slightly acid and are high in natural fertility, but under continuous cropping they are becoming deficient in both nitrogen and phosphorus. Favorable increases in yield have been obtained by using complete fertilizer. The most beneficial results are obtained by using phosphate and nitrogen fertilizers. Chehalis, Cloquato, and Grehalem soils are on alluvial flood plains.

On all the soils in the area, additions of lime and fertilizer should be based on the results of soil tests, on the needs of the crops grown, and on the expected level of yields. The local office of the Cooperative Extension Service can help to determine the kinds and amounts of fertilizer and lime to apply.

Soil tilth is an important factor in the germination and emergence of seeds and in the infiltration of water into the soil. Soils that have good tilth are granular and porous.

Most of the soils used for crops have a silty clay loam or silt loam surface layer that is dark in color and is moderately high in content of organic matter. Regular additions of crop residue, manure, and other organic material can improve soil structure and reduce formation of crusts and hard clods.

Generally, the well drained and moderately well drained soils can be worked early in spring and are sufficiently drained for early crops in spring and for winter grain. Arta, Astoria, Cathlamet, Elochoman, and Germany soils are well drained and moderately well drained.

The surface layer of the poorly drained Nemah and Rennie soils and the very poorly drained Salzer soils is moderately high in clay content. If these soils are moist when plowed, they can be compacted and become very cloddy when dry; good seedbeds are difficult to prepare. Tilth is a concern on these soils because they stay wet until late in spring. Fall plowing generally promotes good tilth in spring.

Soil erosion is a concern on cropland where the soil is barren during the rainy season and slopes are more than 2 percent. Growing a winter cover crop in fields that are continually row cropped helps to protect the soil from erosion. Other erosion control practices include cross slope tilling, planting permanent cover, planting row crops on the contour, application of organic matter, and using vegetated waterways to handle excess water.

The most intensive farming in the area is done on the fertile alluvial flood plains. The principal crops-generally grown for dairy cattle-are corn silage, small grain, hay, and pasture. The well drained soils on the flood plains, such as those of the Chehalis, Cloquato, and Grehalem series, are naturally fertile and produce high yields. Summer pasture, clover, and alfalfa in areas near an adequate water supply are benefited by irrigation during the drier years.

Soil erosion on pastureland can be controlled and the quality and quantity of the forage maintained by (1) establishing a planned pasture grazing system with a minimum of three pastures where key plants can be grazed at the proper time and the proper height; (2) applying commercial fertilizer according to the precipitation, soils, and plant composition; (3) clipping and dragging pasture at least twice a year; and (4) avoiding grazing when the soil is wet and allowing a minimum of 3 to 5 days for the soils in irrigated pasture to dry, depending on their texture.

Soil erosion on hayland can be controlled and the quality and quantity of the hay maintained by (1) harvesting the hay when it is of the highest quality and quantity and when the least damage is done to the stand, (2) removing the hay from the field before it smothers and damages plants in the stand, and (3) following applicable grazing specifications if aftermath is grazed.

Specialty crops grown commercially in the survey area are cranberries, flower bulbs, peas, sweet corn, and Christmas trees. Most of these crops are grown along the Chehalis River and its tributaries and on Puget Island, in the Columbia River.

Christmas tree production is gaining steadily in popularity. Douglas-fir, true firs, and Scotch pine are the most common species planted.

The latest information and suggestions for growing specialty crops can be obtained from local offices of the Soil Conservation Service and the Cooperative Extension Service.

Yields per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop

residue, barnyard manure, and green manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops (27). Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w,* s, or c, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; w shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); s shows that the soil is limited mainly because it is shallow, droughty, or stony; and c, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by w, s, or c because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Woodland Management and Productivity

By Lyn Townsend and Gregory S. Fisher, foresters, Soil Conservation Service, and George Carnine, forester, Washington State Department of Natural Resources.

This survey area is recognized as one of the best timber-growing regions in North America. Its potential for high productivity is the result of a favorable climate, the fertility of the soils, and the presence of well suited timber species. About 92 percent of the area is woodland. About 97 percent of this woodland is classified as commercial forest land, 2 percent as unproductive forest land, and 1 percent as productive-reserve, such as Federal, State, and county parks.

The major part of the commercial forest land, 55 percent, is owned by the forest industry, 17 percent is owned by farmers and other private parties, and 28 percent is publicly owned.

The survey area can be broken down into six major "soil-woodland" zones. These zones are based on forest overstory species, climate, and soil characteristics. Although the species in the zone name predominate, associated woodland species commonly occur in nearly pure stands. Boundary lines between zones should be thought of as gradual changes in vegetation and soil rather than a precise division. With few exceptions, each soil-woodland zone is characterized by certain soil series and map units; that is, any given soil will be found only in its related zone. A brief description of each zone follows.

Western hemlock-Sitka spruce zone.-This zone is at sea level to 500 feet. Temperatures in this zone are mild, and the growing season (at 28 degrees F) is 180 to 220 days. The mean annual precipitation is 70 to 100 inches.

The soil moisture content is adequate for tree growth in summer. The soils are mostly very deep and poorly drained to well drained. Typical soils in this zone are those of the Netarts, Newskah, and Yaquina series and the cool phases of the Calawah, Ilwaco, Lebam, Mopang, Oyhut, Palix, Vesta, and Willapa soils. Associated woodland species include western redcedar, Douglas-fir, red alder, and some Pacific silver fir. Shore pine grows in some areas on stabilized sand dunes near the coast. Common forest understory species are salmonberry, sedge, salal, cascara buckthorn, skunkcabbage, western brackenfern, evergreen huckleberry, and western swordfern.

The main forest management concerns in this zone are limitations for harvesting during the rainy season; invasion of cutover areas by brush, which can prevent reforestation; and high seedling mortality on the poorly drained soils. The management practices generally used include clear-cut harvesting when stands reach an age of 45 to 60 years and disposing of unused woody material and brush by broadcast burning or piling and burning. Reforestation generally consists of hand planting Douglas-fir or relying on natural reforestation of cutover areas by western hemlock and Sitka spruce. The planting of Sitka spruce has declined because widespread damage has been inflicted by the Sitka spruce weevil. The weevil damages or kills the terminal growth of the preceding year. Five- to thirty-year-old trees are most commonly injured, resulting in a reduced volume of production and a deterioration of quality.

Western hemlock zone.-This zone is at elevations of 20 to 1,000 feet. The temperatures in this zone are mild, and the growing season (at 28 degrees F) is 180 to 220 days. The mean annual precipitation is 70 to 100 inches. Soil moisture content is adequate for tree growth in summer. The soils are mostly very deep and moderately well drained to well drained. Typical soils in this zone are those of the Calawah, Ilwaco, Knappton, Lebam, Mopang, Narel, Oyhut, Palix, Papac, Traham, Vesta, and Willapa series. Associated woodland species include Sitka spruce, western redcedar, shore pine, western white pine, and red alder. Common forest understory species are western brackenfern, red huckleberry, western swordfern, salal, salmonberry, deer fern, Oregon oxalis, red elderberry, and evergreen huckleberry.

Forest management concerns and practices applicable in this zone are essentially the same as those listed for the western hemlock-Sitka spruce zone, but less Sitka spruce is available for natural reforestation. The principal reason that western hemlock predominates in most areas of this zone is the forest management practices used in the early 1900's. Old growth stands were harvested, and the areas were not reforested with Douglas-fir. An abundance of seed-producing western hemlock left after cutting quickly led to establishment of nearly pure stands.

Douglas-fir- western hemlock-red alder.-This is the largest zone. It is at elevations of 20 to 1,800 feet. Temperatures in this zone are mild, and the growing season (at 28 degrees F) is 200 to 240 days. The mean annual precipitation is 70 to 150 inches. The soil moisture content is adequate for tree growth in summer. The soils in this zone are mostly very deep and moderately well drained to well drained. They include those of the Astoria, Boistfort, Bunker, Copalis, Elochoman, Hoquiam, Katula, Le Bar, Lytell, Nordby, O'Brien, Willaby, Zenker, and Zyzyl series. Associated woodland species include western redcedar, Sitka spruce, bigleaf maple, and black cottonwood. Common forest understory species are red huckleberry, western swordfern, salal, Oregon-grape, western brackenfern, salmonberry, vine maple, violet, Oregon oxalis, devilsclub, and candy flower.

Western hemlock-Douglas-fir-Pacific silver fir.-This zone is at elevations of 1,800 to 2,700 feet. Temperatures in this zone are cool, and the growing season (at 28 degrees F) is 150 to 180 days. Typical soils in this zone are those of the Lates and Murnen series. The associated woodland species are red alder and western redcedar. The common forest understory species essentially are the same as those in the Douglas-fir-western hemlock-red alder zone.

Forest management concerns and practices applicable to the Douglas-fir-western hemlock-red alder zone and the western hemlock-Douglas-fir-Pacific silver fir zone are similar to those of the western hemlock zone. A major difference is not being able to rely on natural reforestation by western hemlock. If hemlock seeds are present, however, cutting methods can be altered to encourage natural reforestation. Western hemlock can tolerate more shade than Douglas-fir, which makes encroachment by brush less of a concern. Also, in terms of total wood fiber production, natural stands of western hemlock generally can produce more than those of Douglas-fir within all four of the zones described. Advance reforestation of Pacific silver fir takes place in some of the areas within the western hemlock-Douglas-fir-Pacific silver fir zone; however, mechanical damage to these seedlings during harvesting can result in poor quality or an inadequate degree of reforestation. Noble fir shows promise of being better suited for reforestation on ridgetops in this high-elevation zone.

Douglas-fir-red alder zone.-This zone is at elevations of 100 to 1,500 feet. Temperatures are mild, and the growing season (at 28 degrees F) is 200 to 240 days. The mean annual precipitation is 50 to 70 inches. There is a limited amount of soil moisture available for tree growth in summer. The soils in this zone are mostly very deep and poorly drained to well drained. They include those of the Buckpeak, Cathlamet, Centralia, Germany, Melbourne, Olympic, Raught, Schneider, and Tebo series. Associated woodland species include western redcedar, bigleaf maple, western hemlock, grand fir, and

black cottonwood. Common forest understory species are salal, Oregon-grape, western brackenfern, western swordfern, vine maple, red huckleberry, trailing blackberry, Pacific trillium, northern twinflower, hollyfern, violet, and Oregon oxalis.

The main forest management concerns in this zone are limitations for harvesting during the rainy season; invasion of cutover areas by brush, which can prevent reforestation; and high seedling mortality on the poorly drained soils. Suitable management practices are clear-cut harvesting when stands reach an age of 45 to 60 years, disposing of unused woody material and brush in preparation for reforestation, and hand planting Douglas-fir seedlings during the first planting season after harvest. Red alder commonly invades disturbed cut-over areas and competes with Douglas-fir. Thinning and fertilizing young stands of Douglas-fir increase commercial yields at the time of intermediate and final harvests. Young red alder stands are commonly thinned and, because of their nitrogen fixing capability, are not fertilized.

Douglas-fir-Oregon white oak (prairie) zone.-This zone is the smallest. It is at elevations of about 100 to 200 feet. Temperatures are mild, and there is a limited amount of soil moisture available for tree growth in summer. The soils in this zone are very deep and well drained to excessively drained. Typical soils are those of the Lyre and Spanaway series. Lodgepole pine occurs occasionally as an associated species in some areas. Common forest understory species are snowberry, salal, western brackenfern, Scotch broom, Oregon-grape, oceanspray, and Indian plum.

The main forest management concern in this zone is high mortality of seedlings because of droughtiness. The soils of this area are well suited to year-round logging. Little management is used in this zone because most of the area is either used for or reserved for housing developments or has been cleared for agricultural uses.

Soil surveys are becoming increasingly more important to woodland managers as they seek ways of increasing the productivity of their forested lands. Some soils respond better to fertilization, some are more susceptible to landslides and erosion after roadbuilding and harvesting, and others require special efforts in harvesting and reforesting.

Each map unit suitable for producing wood crops has information concerning woodland productivity, limitations for harvesting timber, concerns for producing timber, and common forest understory plants. The methods and procedures used by foresters and soil scientists to develop the information for each map unit are contained in the Forest Land Grading Procedures Handbook and the Soil Conservation Service National Forestry Manual *(33, 35).*

Table 6 summarizes the forestry information given in the soil map unit descriptions and can serve as a quick reference for important woodland interpretations. *Map unit symbols* are listed in the table, and the *ordination (woodland suitability) symbol* for each unit is given. All soils having the same ordination symbol have about the same potential productivity.

The ordination symbol is based on a uniform system of labeling an individual soil to determine the productivity potential and the principal soil properties in relation to any hazards or limitations of that soil. The first element of the ordination symbol is a number that denotes potential productivity in terms of cubic meters of wood per hectare per year for the indicated tree species (that species listed first in the detailed soil map unit and in table 6 for a particular map unit). Potential productivity is based on site index and the corresponding culmination of mean annual increment. For example, the number 1 indicates a potential production of 1 cubic meter of wood per hectare per year (14.3 cubic feet per acre per year) and 10 indicates a potential production of 10 cubic meters of wood per hectare per year (143 cubic feet per acre per year). The second element of the symbol, a letter, indicates the major kind of soil limitation. The letter w indicates excessive water in or on the soil; s, sandy texture; f, high content of coarse fragments in the soil profile; and r, steep slopes. The letter *a* indicates that there are few if any limitations or restrictions. If a soil has more than one limitation, priority in placing the soil into a limitation class is in the following order: w, s, f, and r.

In table 6 the soils are also rated for a number of factors to be considered in woodland management. *Slight, moderate,* and *severe* are used to indicate the degree of the major soil limitations. For each *moderate* or *severe* rating, a sentence in the applicable detailed soil map unit explains the soil factor or factors that are the basis for that rating.

Equipment limitation ratings refer to the limits on the use of equipment, year-round or seasonal, as a result of soil characteristics. A rating of *slight* indicates that equipment use is not normally restricted in kind or time of year because of soil factors; *moderate* indicates a short seasonal limitation because of soil wetness, a fluctuating water table, or some other factor; and *severe* indicates a seasonal limitation, a need for special equipment, such as a cable-yarding logging system, or a hazard in the use of equipment.

Steepness of slope and soil wetness are the main factors that cause equipment limitations. As slope gradient and length increase, the use of wheeled equipment becomes more difficult. On very steep slopes, tracked equipment must be used. On the steepest slopes, where tracked equipment cannot be operated safely, more sophisticated systems must be used. Soil wetness, especially where the soil material is fine textured, can severely limit the use of equipment and make harvesting practical only during the dry period in summer.

Seedling mortality ratings refer to the probability of death of naturally occurring or planted tree seedlings where influenced by kinds of soil or topographic conditions. Plant competition is not considered in the ratings. The ratings apply to healthy, dormant seedlings from, good stock that are properly planted during a period of sufficient soil moisture. *Slight* indicates that no problem is expected under normal conditions; *moderate* indicates some mortality can be expected and extra precautions are advisable; and *severe* indicates that mortality will be high and that extra precautions are essential for successful reforestation. Soil wetness, droughtiness of the surface layer (especially on south- or southwest-facing slopes), and conditions on the ridgetops are responsible for most seedling mortality. To offset these concerns, larger than normal planting stock, special site preparation, surface drainage, or reinforcement planting may be needed.

Windthrow hazard ratings consider the soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that trees are not normally blown down by wind and that strong winds may break trees but not uproot them; *moderate* indicates that an occasional tree may be blown down during periods of excessive wetness combined with moderate or strong winds; and *severe* indicates that many trees may be blown down during periods when the soil is wet and winds are moderate or strong. Restricted rooting depth because of a high water table, underlying bedrock, or an impervious layer and poor anchoring of roots because of a loose surface layer and subsoil are responsible for windthrow or tree tipover. *Moderate* and *severe* ratings indicate the need for more care in thinning the edges of woodland stands, periodic salvage of windthrown trees, and an adequate road and trail system to allow for salvage.

Plant competition ratings refer to the likelihood of the invasion or growth of undesirable brushy plants when openings are made in the tree canopy. *A slight* rating indicates that unwanted brushy plants are not likely to retard the development of natural reforestation and that planted seedlings have good potential for development without excessive competition; *moderate* indicates that competition will retard natural or planted reforestation; and *severe* indicates that competition can be expected to prevent natural or planted reforestation. Favorable climate and soil characteristics account for plant competition problems. In many cases, the key to predicting brush competition problems is the quantity and proximity of seed sources of undesirable plants or the quantity of unwanted brush rootstock that will resprout after harvesting. *Moderate* and *severe* ratings indicate the need for careful and thorough cleanup after harvesting in preparation for reforestation and for use of mechanical or chemical treatment to retard growth of brush and allow seedlings to develop.

The *potential productivity* of *common trees* on a soil is expressed as *a site index*. This index is determined by taking height and age measurements on selected trees within stands of a given species. The procedure for determining the site index is given in publications used in this soil survey *(3, 11, 14, 37, 41).* The site index applies to fully stocked, even-aged, unmanaged stands growing on a particular detailed soil map unit. The highest timber yields, usually expressed in board feet or cubic feet per acre, can be expected from map units with the highest site indexes. Site index values can be converted into estimated yields at various ages by carefully using the appropriate yield tables *(3, 6, 7, 14, 38, 41).* Important trees are listed in the same order as that of their general occurrence observed on the map unit. Commonly, only one or two woodland species are dominant.

Trees to plant are those that are planted for reforestation or, if suitable conditions exist, are allowed to regenerate naturally. Species listed are suited to the soils and to commercial wood production. The desired product, topographic position (such as a ridgetop), and personal preference are three factors of many that can influence the choice of adapted trees to use for reforestation.

Recreation

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example, interpretations for dwellings without basements and for

local roads and streets in table 9 and interpretations for septic tank absorption fields in table 10.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Ivan L. Lines, Jr., biologist, Soil Conservation Service, helped to prepare this section.

This survey area has a wide variety of habitat that supports many species of wildlife. It varies from saltwater tidelands and shorelines along the Pacific Ocean to the forest plant communities in the Willapa Hills and in the foothills of the Olympic Mountains. Elevation of these areas ranges from sea level to about 2,700 feet.

Several miles of saltwater shorelines and thousands of acres of tidelands provide habitat for oysters, clams, crabs, and numerous young saltwater and freshwater fish. Many species of waterfowl and shorebirds, such as brant, wigeon, gulls, sandpipers, and plovers, also use these areas.

Farms on most of the fertile soils on lowlands, along flood plains, and in many upland areas provide habitat for openland wildlife, such as pheasant, California quail, and rabbits. These areas also commonly supply some habitat for woodland wildlife and waterfowl.

Many areas on the uplands are covered by extensive stands of Douglas-fir, western hemlock, and red alder, and the wet soils and riparian corridors support bigleaf maple, cottonwood, and dogwood. These woodland areas have a diverse understory of salal, Oregon-grape, and huckleberry. The areas provide habitat for woodland wildlife, such as black-tailed deer, elk, cougar, black bear, fox, coyote, woodpeckers, ruffed grouse, and mountain beaver. They also provide food and cover for birds and mammals that feed mainly in forest openings and in areas of cropland.

Most of the streams that flow into the Pacific Ocean once contained large runs of salmon, steelhead, and sea-run cutthroat trout. Some of the runs have been eliminated or reduced, but many streams still support anadromous fish.

The proximity of the survey area to metropolitan areas to the east and the timber production and farming activities in the area have a great impact on wildlife habitat. Few of the soils in the area are managed specifically for wildlife habitat; therefore, management of the soils used mainly for other purposes largely determines the amount and quality of habitat and the abundance of wildlife.

Proper management of the cropland and hay and pasture on general soil map units 1, 2, and 3 can improve wildlife habitat. Suitable practices are planting cover crops, returning crop residue to the soil, leaving strips of undisturbed vegetation along shorelines and streambanks, properly handling livestock waste to prevent pollution of water, and properly using pesticides and chemicals.

Some soils in the area are poorly drained and are suited to the development of ponds and wetland areas. Practices such as building dikes and water control structures can create or improve wetland wildlife habitat.

Use of suitable management practices in the woodland areas of map units 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13 can also enhance wildlife habitat. Small-scale clearcutting helps to create a diversity of successional stages in the vegetation that can result in a wide variety of wildlife habitat. Leaving strips of undisturbed vegetation along stream corridors and shorelines helps to prevent pollution of water sources and destruction of aquatic habitat and provides habitat for wildlife. Leaving standing snags provides habitat for cavity nesting birds and food for many kinds of wildlife. Logging practices that reduce erosion and prevent sediment and debris from entering streams should be used. Disturbed areas,

such as roads, skid trails, and burns, need to be seeded to grasses and legumes to reduce the pollution of water.

Acreage of the soils in map units 3, 4, and 5 is being increasingly used for urban development, and careful planning is needed to preserve as much wildlife habitat in these areas as is feasible. Landscaping urban areas can beautify the areas as well as provide habitat for wildlife. Control of sediment from construction sites is needed to prevent water pollution and disturbance of adjacent areas. Proper disposal systems for sewage, storm runoff, and other possibly harmful pollutants are needed. Strips of riparian vegetation should be maintained to prevent bank erosion, intercept sediment, and provide areas of wildlife habitat.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or *very poor. A rating of good indicates that the element or* kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are western brackenfern and western swordfern.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are red alder, willow, vine maple, and dogwood.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are Douglas-fir, western redcedar, and western hemlock.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are salmonberry, Oregon-grape, salal, huckleberry, snowberry, and elderberry.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, saltgrass, rushes, sedges, and cattail.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include California quail, pheasant, meadowlark, robin, field sparrow, crow, killdeer, and rabbit.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include band-tailed pigeon, ruffed grouse, woodpeckers, mountain beaver, squirrels, black-tailed deer, and black bear.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, kingfishers, muskrat, mink, and beaver.

Engineering

Glenn H. Hough, agricultural engineer, Soil Conservation Service, helped to prepare this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are. required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the

excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 10 shows the degree and the kind of soil limitations that affect tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface (34). There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage because of rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause

construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill-trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair are* sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features listed in tables are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution and plasticity.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas (29). Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (2, 16) and the system adopted by the American Association of State Highway and Transportation Officials (1).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SPSM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-25, A-2-6, A-2-7, A-7-5, or A-7-6.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points)

across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter. No percentages were given for clay in soils that formed in material high in volcanic ash, pumice, or cinders. The textures specified are apparent field textures. Because of the influence of volcanic ash, a complete clay dispersion could not be obtained in the laboratory and the reported clay values are low. The measured physical and chemical properties for these soils indicate a much higher clay content than is reported by the laboratories.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low,* a change of less than 3 percent; *moderate,* 3 to 6 percent; and *high,* more than 6 percent. *Very high,* greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, very fine sand, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Rock fragments in the soil reduce the K value. The K values in table 14 have been modified to reflect the amount of rock fragments in the soil. Values of K range from 0.02 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 14, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 15 gives estimates of various water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups- They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms (28).

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs, on the average, no more than once in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 15 are the depth to the seasonal high water table; the kind of water table-that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in the table.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An *artesian* water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. *A perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Table 16 gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Cemented pans are cemented or indurated subsurface layers within a depth of 5 feet. Such pans cause difficulty in excavation. Pans are classified as thin or thick. *A thin* pan is less than 3 inches thick if continuously indurated or less than 18 inches thick if discontinuous or fractured. Excavations can be made by trenching machines, backhoes, or small rippers. *A thick* pan is more than 3 inches thick if continuously indurated or more than 18

inches thick if discontinuous or fractured. Such a pan is so thick or massive that blasting or special equipment is needed in excavation.

Some of the soils in this survey area are underlain by dense, compact glacial drift. These soils are identified in the detailed map unit descriptions, general map unit descriptions, and series descriptions as having layers of dense glacial drift; in the interpretation tables, however, they are identified as having a cemented pan. For most soil interpretations, the effect of the glacial drift is the same as the effect of a cemented pan.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 16 shows the expected initial subsidence, which usually is a result of drainage, and annual subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed *as low, moderate, or high. It is based on soil texture,* acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (32). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol.* An example is Inceptisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Umbrept *(Umbr,* meaning shade, plus *ept,* from Inceptisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplumbrepts *(Hapl,* meaning minimal horizonation, plus *umbrept,* the suborder of the Inceptisols that have an umbric epipedon).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplumbrepts.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is loamy-skeletal, mixed, mesic Typic Haplumbrepts.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (26).* Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (32).* Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Aabab Series

The Aabab series consists of very deep, somewhat poorly drained soils on river terraces. Aabab soils formed in mixed sedimentary alluvium derived from sandstone and siltstone. Slope is 0 to 3 percent. Elevation is 10 to 500 feet. The average annual precipitation is 75 to 100 inches, the average annual air temperature is about 49 degrees F, and the average growing season is 180 to 220 days.

These soils are fine-silty, mixed, mesic Aquic Dystrochrepts.

Typical pedon of Aabab silt loam, in Pacific County, 8 miles northwest of Naselle, about 1,425 feet west and

1,775 feet north of the southeast corner of sec. 11, T. 11 N., R. 10 W.

O1-1 inch to 0; accumulation of deciduous leaves and twigs.
A11-0 to 3 inches; dark yellowish brown (10YR 3/4) silt loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine tubular pores; medium acid; clear smooth boundary.
A12-3 to 11 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine, medium, and coarse roots; many very fine and common fine tubular pores; strongly acid; clear wavy boundary.
B21-11 to 18 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; few fine and medium distinct grayish brown (10YR 5/2) mottles, light gray (10YR 7/2) dry, and common fine distinct yellowish red (5YR 5/8) mottles, reddish yellow (5YR 6/8) dry; moderate coarse and very coarse prismatic structure; hard, firm, sticky and slightly plastic; few fine roots; many very fine and fine tubular pores; strongly acid; abrupt *wavy* boundary.
B22-18 to 21 inches; brown (10YR 5/3) silty clay loam, light gray (10YR 7/2) dry; common fine and medium distinct yellowish red (5YR 5/8) mottles, reddish yellow (5YR 6/8) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few very fine tubular pores; medium acid; clear wavy boundary.
B23-21 to 43 inches; yellowish brown (10YR 5/4) silty clay loam, very pale brown (10YR 7/3) dry; many fine and medium distinct yellowish red (5YR 4/8) mottles, yellowish red (5YR 5/8) dry; moderate very coarse prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; few fine roots; many very fine and fine tubular pores; dark reddish brown (2.5YR 3/4) iron coatings on some peds, reddish brown (2.5YR 4/4) dry; strongly acid; clear smooth boundary.
Cg-43 to 60 inches; greenish gray (5GY 5/1) silty clay loam, light gray (2.5Y 7/2) dry; few fine distinct dark greenish gray (5BG 4/1) mottles, not visible when dry; massive; very hard, very firm, sticky and plastic; common very fine and fine tubular pores; medium acid.

The solum is 35 to 52 inches thick. The control section is 25 to 35 percent clay.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 3 or 4 when moist and 4 to 6 when dry, and chroma of 3 to 5 when moist or dry. If value is 3 and chroma is 3, the horizon is less than 10 inches thick.

The B horizon has value of 4 or 5 when moist and 5 to 7 when dry, and it has chroma of 3 to 5 when moist and 2 to 4 when dry. It is- silt loam or silty clay loam.

The C horizon has hue of 2.5Y, 5Y, or 5GY when moist or dry, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 1 to 3 when moist or dry. It is silt loam or silty clay loam.

Arta Series

The Arta series consists of very deep, moderately well drained soils on uplands and terraces. Arta soils formed in material weathered from sandstone, siltstone, and shale. Slope is 0 to 30 percent. Elevation is 50 to 500 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 49 degrees F, and the average growing season is 180 to 200 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Arta silt loam, 0 to 3 percent slopes, in Pacific County, 3 miles southeast of Menlo, about 2,600 feet east and 2,350 feet south of the northwest corner of sec. 24, T. 13 N., R. 8 W.

Ap-0 to 6 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; strong fine and very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine and very fine roots; common very fine interstitial pores; strongly acid; clear smooth boundary.
A12-6 to 18 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; strong very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine and very fine roots; common very fine interstitial pores; strongly acid; clear wavy boundary.
B1-18 to 26 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; strong fine and very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and very fine roots; many fine and very fine tubular pores; very strongly acid; gradual wavy boundary.
B21-26 to 39 inches; dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; few fine distinct strong brown (7.5YR 5/6) mottles, reddish yellow (7.5YR 6/8) dry; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and very fine roots; common fine tubular pores; 10 percent rounded fragments of soft sandstone; very strongly acid; clear smooth boundary.
B22-39 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (2.5Y 6/4) dry; common fine distinct strong brown (7.5YR 5/6) mottles, reddish yellow (7.5YR 6/8) dry, and

common fine distinct gray (10YR 5/1) mottles, light gray (10YR 7/1) dry; weak fine subangular blocky structure; hard, friable, sticky and slightly plastic; few very fine roots; common fine tubular pores; 5 percent rounded fragments of soft sandstone; very strongly acid.

The solum is 40 inches to more than 60 inches thick, and depth to bedrock is more than 60 inches. Depth to mottles that have chroma of 2 or less is 25 to 50 inches. The 10- to 40-inch control section is 27 to 35 percent clay and less than 15 percent coarse fragments.

The A horizon has hue of 10YR or 7.5YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 to 3 when moist or dry.

The B horizon has hue of 7.5YR, 10YR, or 2.5Y when moist or dry, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 3 to 6 when moist or dry. It is dominantly silty clay loam but ranges to silty clay below a depth of 40 inches in some areas. The B horizon is 0 to 15 percent pebble-sized fragments of soft sedimentary rock.

Astoria Series

The Astoria series consists of very deep, well drained soils on uplands. Astoria soils formed in material weathered from siltstone. Slope is 3 to 65 percent. Elevation is 50 to 1,000 feet. The average annual precipitation is about 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Astoria silt loam, 3 to 8 percent slopes, in Wahkiakum County, 4 miles north of Rosburg, about 1,900 feet east and 900 feet south of the northwest corner of sec. 3, T. 10 N., R. 8 W.

A1-0 to 12 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; strong medium, fine, and very fine granular structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few coarse roots and many medium and fine roots; many micro interstitial pores; 5 percent pebble-sized fragments of soft siltstone; very strongly acid; abrupt wavy boundary.

B1-12 to 24 inches; dark yellowish brown (10YR 3/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate medium and coarse subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common medium and fine roots; common medium and many very fine tubular pores; 10 percent pebble-sized fragments of soft siltstone; very strongly acid; gradual wavy boundary.

B2-24 to 60 inches; dark yellowish brown (10YR 3/4) silty clay, yellowish brown (10YR 5/4) dry; moderate medium and coarse subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few fine roots; few medium and common fine and very fine tubular pores; 15 to 20 percent pebble-sized fragments of soft siltstone; very strongly acid.

The 10- to 40-inch control section is silty clay or silty clay loam that averages 30 to 50 percent clay and less than 15 percent rock fragments.

The B horizon has value of 3 or 4 when moist. It is silty clay loam to silty clay.

Bear Prairie Series

The Bear Prairie series consists of very deep, well drained soils on terraces. Bear Prairie soils formed in old alluvium. Slope is 0 to 3 percent. Elevation is 20 to 300 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Typic Dystrandepts.

Typical pedon of Bear Prairie silt loam, 0 to 3 percent slopes, in Wahkiakum County, 4 miles southwest of Rosburg, about 550 feet south and 1,750 feet west of the northeast corner of sec. 32, T. 10 N., R. 8 W.

A11-0 to 3 inches; very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; weak very fine and fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine, fine, medium, and coarse roots; many micro interstitial pores; extremely acid; abrupt wavy boundary.

A12-3 to 8 inches; very dark brown (10YR 2/2) silt loam, dark brown (10YR 3/3) dry; moderate very fine and fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; weakly smeary; many very fine roots, common fine roots, and few medium and coarse roots; many very fine tubular pores; very strongly acid; clear wavy boundary.

A13-8 to 12 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate very fine and fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; weakly smeary; many very fine roots, common fine roots, and few medium and coarse roots; many very fine tubular pores; very strongly acid; clear wavy boundary.

B1-12 to 29 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; strong medium and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; common very fine tubular pores; strongly acid; abrupt irregular boundary.

B2-29 to 60 inches; dark yellowish brown (10YR 3/4) silty clay loam, dark yellowish brown (10YR 4/4) dry; strong medium, coarse, and very coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; common very fine tubular pores; strongly acid.

The 10- to 40-inch control section is typically silty clay loam but ranges to silt loam in some places.

The A horizon has value of 2 or 3 when moist and 3 or 4 when dry, and it has chroma of 2 or 3 when moist or dry.

The B horizon has value and chroma of 3 or 4 when moist or dry.

Boistfort Series

The Boistfort series consists of very deep, well drained soils on uplands. Boistfort soils formed in material weathered from basalt. Slope is 1 to 65 percent. Elevation is 100 to 1,800 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Boistfort silt loam, 1 to 8 percent slopes, in Pacific County, 6 miles south of Brooklyn, about 500 feet due west of the northeast corner of sec. 12, T. 14 N., R. 7 W.

O1-4.5 inches to 0; accumulation of Douglas-fir and western hemlock needles and twigs.
A1-0 to 12 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 4/3) dry; strong fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common coarse roots and many medium, fine, and very fine roots; common very fine tubular pores; very strongly acid; clear smooth boundary.
B1-12 to 17 inches; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; moderate very fine subangular blocky structure; slightly hard, friable, sticky and slightly plastic; weakly smeary; common medium roots and many fine and very fine roots; common fine and very fine tubular pores; very strongly acid; abrupt smooth boundary.
B2-17 to 60 inches; dark brown (7.5YR 4/4) silty clay, strong brown (7.5YR 5/6) dry; moderate fine subangular blocky structure; hard, firm, sticky and plastic; weakly smeary; few coarse, medium, and fine roots; common fine and very fine tubular pores; 3 percent pebble-sized fragments of basalt; very strongly acid.

The solum is 40 inches to more than 60 inches thick. The content of coarse fragments ranges from 0 to 35 percent, but it averages less than 10 percent. Hue is 5YR or 7.5YR when moist.

The A horizon has value and chroma of 2 or 3 when moist. When dry, value and chroma are 1 unit higher in some places.

The B horizon has value and chroma of 4 to 6 when moist. It is clay loam, silty clay loam, and silty clay and is gravelly silty clay loam or gravelly silty clay in the lower part in some pedons.

Buckpeak Series

The Buckpeak series consists of deep, well drained soils on uplands. Buckpeak soils formed in residuum and colluvium derived from siltstone and very fine sandstone. Slope is 8 to 90 percent. Elevation is 300 to 1,200 feet. The average annual precipitation is about 60 to 75 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are fine-loamy, mixed, mesic Typic Xerumbrepts.

Typical pedon of Buckpeak silt loam, 30 to 65 percent slopes, in Grays Harbor County, 8 miles south of Elma, about 2,400 feet east and 400 feet north of the southwest corner of sec. 35, T. 17 N., R. 6 W.

O1-1 inch to 0; accumulation of Douglas-fir needles and twigs.
A11-0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; strong fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine, medium, and coarse roots; many very fine and fine interstitial pores; 10 percent medium iron-manganese concretions; 10 percent angular, pebble-sized fragments of soft siltstone; strongly acid; clear wavy boundary.
A12-7 to 16 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; strong fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine, medium, and coarse roots; many fine tubular pores; 20 percent angular, pebble-sized fragments of soft siltstone; strongly acid; gradual wavy boundary.
B2-16 to 29 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; moderate fine subangular blocky structure; hard, firm, sticky and plastic; common fine and medium roots; common fine tubular pores; 35 percent angular, pebble-sized fragments of soft siltstone; very strongly acid; gradual wavy boundary.
B3-29 to 47 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common fine tubular pores; 60 percent angular, pebble-sized fragments of soft siltstone; very strongly acid; clear wavy boundary.
Cr-47 inches; partly consolidated siltstone.

Thickness of the solum and depth to paralithic contact are 40 inches to more than 60 inches. Reaction ranges from medium acid to very strongly acid. The umbric epipedon is 14 to 19 inches thick.

The A horizon has hue of 10YR or 7.5YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B2 horizon has hue of 10YR or 7.5YR when moist or dry, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 to 5 when moist and 4 to 6 when dry. It is silty clay loam or silt loam. The content of angular, pebble-sized fragments of soft siltstone or sandstone ranges from 15 to 40 percent.

The B3 horizon is silty clay loam or silt loam. The content of angular, pebble-sized fragments of soft siltstone or sandstone ranges from 40 to 70 percent.

Bunker Series

The Bunker series consists of deep, well drained soils on uplands. Bunker soils formed in colluvium derived from basalt. Slope is 5 to 90 percent. Elevation is 100 to 1,800 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Bunker silt loam, 5 to 30 percent slopes, in Wahkiakum County, 9 miles northwest of Skamokawa, about 650 feet west and 500 feet north of the southeast corner of sec. 3, T. 10 N., R. 6 W.

O1-1 inch to 0; partially decomposed leaf litter.

A11-0 to 6 inches; black (5YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak medium, fine, and very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many fine and very fine roots; many micro-interstitial pores; very strongly acid; clear wavy boundary.

A12-6 to 13 inches; dark reddish brown (5YR 3/2) silt loam, dark brown (10YR 3/3) dry; moderate medium, fine, and very fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many medium and fine roots; many micro-interstitial pores; 10 percent angular basalt pebbles; strongly acid; clear wavy boundary.

B21-13 to 22 inches; dark yellowish brown (10YR 3/4) gravelly silt loam, yellowish brown (10YR 5/4) dry; moderate medium, fine, and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common coarse, medium, and fine roots; many micro-interstitial pores; 20 percent angular basalt pebbles; strongly acid; gradual wavy boundary.

B22-22 to 34 inches; dark brown (10YR 3/3) gravelly silt loam, light yellowish brown (10YR 6/4) dry; moderate medium, fine, and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common coarse and medium roots; many fine tubular pores; 20 percent angular basalt pebbles; strongly acid; clear wavy boundary.

B23-34 to 50 inches; dark brown (10YR 3/3) gravelly silt loam, yellowish brown (10YR 5/4) dry; moderate coarse and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; few medium roots; many fine tubular pores; 25 percent angular basalt pebbles; very strongly acid; abrupt wavy boundary.

R-50 inches; fractured basalt.

The depth to bedrock ranges from 40 to 60 inches or more.

The A horizon has hue of 5YR or 7.5YR when moist or dry, value of 2 or 3 when moist, and chroma of 1 or 2 when moist and 1 to 3 when dry. It is 0 to 15 percent pebbles and cobbles.

The B horizon has hue of 7.5YR or 10YR when moist or dry, and it has value of 5 or 6 when dry. It is gravelly silt loam or gravelly silty clay loam and is 15 to 35 percent rock fragments.

Calawah Series

The Calawah series consists of very deep, well drained soils on high terraces. Calawah soils formed in glaciofluvial sediment and valley fill material of mixed origin. Slope is 1 to 30 percent. Elevation is sea level to 400 feet. The average annual air temperature is about 46 to 48 degrees F, the average annual precipitation is 80 to 120 inches, and the average growing season is 180 to 220 days.

These soils are medial, mesic Typic Dystrandepts.

Typical pedon of Calawah silt loam, 1 to 8 percent slopes, in Grays Harbor County, 12 miles southwest of Aberdeen, about 2,200 feet west and 1,400 feet south of the northeast corner of sec. 19, T. 16 N., R. 10 W.

O1-1 inch to 0; accumulation of western hemlock needles and twigs.

A1-0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; strong fine and medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; many very fine interstitial pores; very strongly acid; clear smooth boundary.

A3-8 to 16 inches; dark brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common fine and very fine roots; many very fine tubular pores; very strongly acid; clear smooth boundary.

B21-16 to 44 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; common very fine tubular pores; very strongly acid; gradual wavy boundary.

B22-44 to 60 inches; dark yellowish brown (10YR 4/6) silt loam, brownish yellow (10YR 6/6) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and plastic; weakly smeary; few very fine roots; common very fine tubular pores; very strongly acid.

The solum is 60 inches to more than 100 inches thick. The 10- to 40-inch control section has 20 to 27 percent clay. Reaction is very strongly acid or strongly acid.

The Al horizon has hue of 10YR or 7.5YR when moist or dry, and it has chroma of 2 or 3 when moist and 2 to 4 when dry.

The A3 horizon has hue of 10YR or 7.5YR when moist or dry, value of 4 or 5 when dry, and chroma of 3 or 4 when dry.

The B horizon has hue of 10YR or 7.5YR when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 3 to 6 when moist or dry. The horizon is dominantly silt loam, but in some places it is silty clay loam below a depth of 40 inches. The content of rounded pebbles ranges from 0 to 15 percent.

Carstairs Series

The Carstairs series consists of very deep, somewhat excessively drained soils on outwash terraces. Carstairs soils formed in extremely gravelly glacial outwash. Slope is 1 to 8 percent. Elevation is 100 to 200 feet. The average annual precipitation is 70 to 80 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are sandy-skeletal, mixed, mesic Andic Xerumbrepts.

Typical pedon of Carstairs very gravelly loam, 1 to 8 percent slopes, in Grays Harbor County, 1 mile west of Satsop, about 200 feet east and 1,000 feet north of the southwest corner of sec. 36, T. 18 N., R. 7 W.

A1-0 to 14 inches; very dark brown (10YR 2/2) very gravelly loam, very dark grayish brown (10YR 3/2) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine roots and common coarse roots; 60 percent waterworn pebbles; very strongly acid; clear smooth boundary.

B2-14 to 28 inches; dark yellowish brown (10YR 4/4) extremely gravelly loamy sand, yellowish brown (10YR 5/4) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; 75 percent waterworn pebbles; medium acid; clear smooth boundary.

IIC-28 to 60 inches; dark grayish brown (2.5Y 4/2) extremely gravelly sand, grayish brown (2.5Y 5/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots to a depth of 40 inches; 80 percent waterworn pebbles; medium acid.

Solum thickness and depth to extremely gravelly sand range from 18 to 30 inches. The content of coarse fragments in the control section averages 60 to 80 percent. The umbric epipedon is 10 to 16 inches thick.

The A1 horizon has chroma of 1 or 2 when moist or dry.

The B2 horizon has value of 4 or 5 when dry and 3 or 4 when moist, and it has chroma of 3 or 4 when moist or dry. This horizon is dominantly extremely gravelly loamy sand, but in some places it is extremely gravelly sandy loam.

The IIC horizon has value of 4 or 5 when moist or dry.

Cathlamet Series

The Cathlamet series consists of very deep, well drained soils on uplands. Cathlamet soils formed in material weathered from sandstone. Slope is 1 to 65 percent. Elevation is 50 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andic Xerochrepts.

Typical pedon of Cathlamet silt loam, 1 to 8 percent slopes, in Wahkiakum County, 1 mile west of Cathlamet, about 2,400 feet east and 600 feet south of the northwest corner of sec. 12, T. 8 N., R. 6 W.

Ap-0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, dark yellowish brown (10YR 4/4) dry; moderate medium and fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and many very fine roots; many very fine interstitial pores; slightly acid; clear smooth boundary.

A12-5 to 12 inches; dark brown (7.5YR 3/4) silt loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure parting to moderate fine subangular blocky; slightly hard, friable, sticky and plastic; weakly smeary; many fine and very fine roots; many very fine interstitial pores; medium acid; gradual wavy boundary.

B21-12 to 22 inches; dark brown (7.5YR 4/4) silt loam, yellowish brown (10YR 5/4) dry; moderate medium and coarse subangular blocky structure parting to moderate fine subangular blocky; slightly hard, friable, sticky and plastic; weakly smeary; common coarse, fine, and very fine roots; common very fine tubular pores; medium acid; gradual wavy boundary.

B22-22 to 60 inches; dark brown (7.5YR 4/4) silty clay loam, yellowish brown (10YR 5/6) dry; strong coarse subangular blocky structure parting to moderate fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and very fine roots; many fine and very fine tubular pores; medium acid.

The 10- to 40-inch control section is silt loam that averages 20 to 30 percent clay and less than 15 percent rock fragments.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 4 or 5 when dry, and chroma of 2 to 4 when moist.

The B horizon has hue of 7.5YR or 10YR when moist or dry, and it has chroma of 4 to 6 when dry. It is silt loam or silty clay loam.

Centralia Series

The Centralia series consists of very deep, well drained soils on uplands. Centralia soils formed in material weathered from sandstone. Slope is 1 to 65 percent. Elevation is 200 to 1,200 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season is 200 to 240 days.

These soils are fine-loamy, mixed, mesic Ultic Haploxeralfs.

Typical pedon of Centralia loam, 8 to 30 percent slopes, in Grays Harbor County, 6 miles southwest of Elma, about 2,400 feet west and 1,200 feet north of the southeast corner of sec. 24, T. 17 N., R. 6 W.

O1-3 inches to 1 inch; accumulation of Douglas-fir needles and twigs.
O2-1 inch to 0; decomposed needles and twigs.
A11-0 to 6 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; strong medium granular structure; hard, very friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots and common coarse roots; many very fine interstitial pores; 5 percent medium iron-manganese concretions; medium acid; gradual wavy boundary.
A12-6 to 14 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; strong fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; common fine tubular pores; medium acid; clear wavy boundary.
B21t-14 to 30 inches; dark yellowish brown (10YR 4/4) clay loam, light yellowish brown (10YR 6/4) dry; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; common very fine, fine, and coarse roots; common very fine tubular pores; few thin clay films on faces of peds and in pores; strongly acid; gradual wavy boundary.
B22t-30 to 50 inches; dark brown (7.5YR 4/4) clay loam, brownish yellow (10YR 6/6) dry; moderate fine and medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine roots; common very fine tubular pores; few thin clay films on faces of peds and in pores; strongly acid; clear wavy boundary.
C-50 to 60 inches; dark brown (7.5YR 4/4) loam, strong brown (7.5YR 5/6) dry; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; 30 percent angular, pebble-sized fragments of soft sandstone; very strongly acid.

The solum is 40 to 70 inches thick. The control section is silty clay loam or clay loam. It is 27 to 35 percent clay and more than 15 percent material that is coarser than very fine sand. The argillic horizon is 25 to 60 inches thick. Hue is 10YR or 7.5YR throughout when moist or dry.

The A horizon has value of 2 or 3 when moist, and it has chroma of 2 or 3 when moist or dry.

The B2t horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist and 4 to 6 when dry. It is clay loam or silty clay loam and is medium acid or strongly acid.

The C horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 2 to 6 when moist or dry. It is clay loam, silty clay loam, or loam and is strongly acid or very strongly acid.

Chehalis Series

The Chehalis series consists of very deep, well drained soils on flood plains. Chehalis soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 50 to 200 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 52 degrees F, the average growing season is 200 to 220 days, and the average frost-free season is 150 to 210 days.

These soils are fine-silty, mixed, mesic Cumulic Ultic Haploxerolls.

Typical pedon of Chehalis silt loam, in Grays Harbor County, 0.5 mile west of Porter, about 2,250 feet east and 100 feet south of the northwest corner of sec. 28, T. 17 N., R. 5 W.

Ap-0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine and medium roots; many fine and medium pores; medium acid; abrupt smooth boundary.
A12-8 to 12 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine roots; many fine and

medium pores; medium acid; clear smooth boundary.

B21-12 to 24 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; strong fine subangular blocky structure; hard, friable, sticky and plastic; common fine roots; many fine tubular pores; slightly acid; gradual smooth boundary.

B22-24 to 52 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; strong fine subangular blocky structure; hard, friable, sticky and plastic; few fine roots; many fine tubular pores; slightly acid; abrupt smooth boundary.

C-52 to 60 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (2.5Y 6/4) dry; massive; soft, friable, slightly sticky and slightly plastic; many fine and medium tubular pores; neutral.

The control section is silt loam or silty clay loam that is 25 to 35 percent clay. Reaction of the solum ranges from neutral to medium acid.

Cloquato Series

The Cloquato series consists of very deep, well drained soils on flood plains. Cloquato soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 50 to 150 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 52 degrees F, the average growing season is 200 to 220 days, and the average frost-free season is 150 to 210 days.

These soils are coarse-silty, mixed, mesic Cumulic Ultic Haploxerolls.

Typical pedon of Cloquato silt loam, in Grays Harbor County, 1 mile southwest of Oakville, about 2,000 feet east and 1,000 feet south of the northwest corner of sec. 36, T. 16 N., R. 5 W.

Ap-0 to 9 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine granular structure; hard, friable, nonsticky and slightly plastic; many fine fibrous roots; many fine and medium interstitial pores; slightly acid; abrupt smooth boundary.

A3-9 to 36 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak very fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common fine and medium roots; many fine and medium interstitial pores and common coarse tubular pores; slightly acid; clear wavy boundary.

C1-36 to 57 inches; dark brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; weak very fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine fibrous roots; many fine interstitial pores and many medium and common coarse tubular pores; slightly acid; gradual wavy boundary.

IIC2-57 to 60 inches; dark brown (10YR 3/3) sandy loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few roots; common fine, medium, and coarse tubular and interstitial pores; slightly acid.

The control section is dominantly silt loam, and less than 15 percent of the material is coarser than very fine sand. Hue is 10YR or 2.5Y when moist or dry.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The C horizon has value of 3 to 6 when moist or dry, and it has chroma of 2 to 4 when moist or dry. It ranges from sand to silt loam; sandy loam and coarser textured material are at a depth of more than 40 inches.

Copalis Series

The Copalis series consists of moderately deep, well drained soils on glaciofluvial terraces. Copalis soils formed in material weathered from glacial drift. Slope is 1 to 65 percent. Elevation is 30 to 800 feet. The average annual precipitation is about 80 to 140 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Copalis silt loam, 8 to 30 percent slopes, in Grays Harbor County, 30 miles north of Hoquiam, about 1,440 feet north of the southwest corner of sec. 2, T. 21 N., R. 10 W.

O1-1.5 inches to 1 inch; conifer needles, branches, bark, and moss.

O2-1 inch to 0; decomposed needles, bark, and moss; much mycelial growth.

A11-0 to 3 inches; dark reddish brown (5YR 3/2) silt loam dark grayish brown (10YR 4/2) and reddish brown (5YR 4/3) dry; moderate fine and medium granular structure; slightly hard, very friable, nonsticky and nonplastic; weakly smeary; common coarse, medium, and fine roots; many fine and medium pores; 20 percent soft rounded fine pebbles; 15 percent soft iron-manganese concretions; very strongly acid; abrupt wavy boundary.

A12-3 to 8 inches; dark brown (7.5YR structure 3/2) silt loam, dark brown (10YR 4/3) dry; weak fine granular structure and moderate very fine subangular blocky; slightly hard, very friable, slightly sticky and nonplastic; weakly smeary; common coarse, medium, and fine roots; many fine and medium pores; 20 percent angular and rounded soft fine pebbles; 15 percent soft iron-manganese concretions; very strongly acid; clear wavy boundary.

B21-8 to 18 inches; dark reddish brown (5YR 3/3) silt loam, structure dark brown (7.5YR 3/4) dry; moderate very fine subangular blocky and moderate

fine and medium granular; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; many fine and medium pores; 20 percent soft fine pebbles; 5 percent soft iron-manganese concretions; strongly acid; gradual wavy boundary.

B22-18 to 25 inches; dark reddish brown (5YR 3/4) silt loam, structure dark brown (7.5YR 3/4) dry; moderate very fine subangular blocky and moderate fine granular; slightly hard, friable, sticky and slightly plastic; weakly smeary; common medium and fine roots; many fine tubular pores; ped surfaces dark reddish brown (5YR 3/3) and reddish brown (5YR 4/4); 30 percent soft fine pebbles; 20 percent soft iron-manganese concretions; strongly acid; abrupt wavy boundary.

IIC1-25 to 37 inches; strong brown (7.5YR 5/6) silt loam, light yellowish brown (10YR 6/4) dry; common medium distinct reddish brown (5YR 4/4) mottles; massive; hard, very firm, slightly sticky and slightly plastic; weakly cemented; few fine roots; few very fine tubular pores; 75 percent rounded and subrounded soft pebbles; strongly acid; abrupt wavy boundary.

IICr-37 inches; dark brown (7.5YR 4/4) dense glacial drift that crushes to extremely gravelly loamy sand, light yellowish brown (10YR 6/4) dry; massive; hard, very firm, nonsticky and nonplastic; strongly cemented; 75 percent fine pebbles; dark reddish brown (2.5YR 2/4) irregular iron-cemented bands 0.25 to 0.5 inch thick at a depth of 37 inches; strongly acid.

The solum is 20 to 36 inches thick. The profile is very strongly acid or strongly acid. The control section averages more than 35 percent soft coarse fragments. The umbric epipedon is 10 to 20 inches thick.

The A horizon has hue of 5YR or 7.5YR when moist and 10YR or 7.5YR when dry, value of 3 or 4 when moist or dry, and chroma of 2 or 3 when moist or dry.

The B horizon has hue of 5YR or 7.5YR when moist and 10YR or 7.5YR when dry, value of 3 or 4 when moist or dry, and chroma of 3 to 6 when moist or dry. It is silt loam or silty clay loam.

The C horizon has hue of 5YR or 7.5YR when moist and 10YR or 7.5YR when dry, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 3 to 6 when moist or dry. It is cemented or compacted.

Elochoman Series

The Elochoman series consists of very deep, well drained soils on uplands. Elochoman soils formed in material weathered from sandstone. Slope is 1 to 65 percent. Elevation is 100 to 1,800 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Elochoman silt loam, 1 to 8 percent slopes, in Wahkiakum County, 7 miles west of Skamokawa, about 1,900 feet south and 550 feet west of the northeast corner of sec. 18, T. 9 N., R. 7 W.

A1-0 to 12 inches; very dark brown (10YR 2/2) silt loam, dark brown (10YR 4/3) dry; moderate coarse and medium subangular blocky structure parting to strong medium and fine granular; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common medium and fine roots; common very fine pores; extremely acid; gradual wavy boundary.

A3-12 to 21 inches; dark brown (10YR 4/3) silt loam, yellowish brown (10YR 5/6) dry; moderate coarse and medium subangular blocky structure parting to strong fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few medium and fine roots; common very fine pores; very strongly acid; clear wavy boundary.

B2-21 to 60 inches; yellowish brown (10YR 5/6) silt loam, yellow (10YR 7/6) dry; weak very coarse and coarse subangular blocky structure parting to moderate coarse and medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few medium and fine roots; few very fine pores; medium acid.

The A1 horizon has value of 2 or 3 when moist and 3 or 4 when dry, and it has chroma of 2 or 3 when moist and 2 to 4 when dry.

The A3 horizon has value of 2 to 4 when moist and 3 to 5 when dry, and it has chroma of 2 or 3 when moist and 2 to 6 when dry.

The B horizon has value of 4 or 5 when moist and 5 to 7 when dry, and it has chroma of 2 to 6 when moist and 3 to 6 when dry.

Germany Series

The Germany series consists of very deep, well drained soils on uplands. Germany soils formed in loess and material weathered from basalt. Slope is 1 to 65 percent. Elevation is 400 to 1,500 feet. The average annual precipitation is 55 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 220 to 240 days.

These soils are medial, mesic Andic Xerumbrepts.

Typical pedon of Germany silt loam, 1 to 8 percent slopes, in Wahkiakum County, 6 miles southeast of Cathlamet, about 2,000 feet west and 2,500 feet south of the northeast corner of sec. 22, T. 8 N., R. 5 W.

O1-3 inches to 0; partially decomposed leaves and twigs.

A11-0 to 5 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 5/4) dry; strong medium and fine

granular structure; hard, very friable, slightly sticky and nonplastic; weakly smeary; common medium and fine roots; many fine and very fine tubular pores; medium acid; gradual wavy boundary.

A12-5 to 11 inches; dark brown (7.5YR 3/3) silt loam, brown (7.5YR 5/4) dry; strong fine and very fine subangular blocky structure; hard, very friable, nonsticky and nonplastic; weakly smeary; common medium and coarse roots; many fine and very fine tubular pores; medium acid; gradual wavy boundary.

A3-11 to 24 inches; dark brown (7.5YR 3/3) silt loam, strong brown (7.5YR 5/6) dry; moderate coarse, medium, and fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; weakly smeary; common medium roots and few fine and very fine roots; many medium tubular pores and common fine and very fine tubular pores; medium acid; clear wavy boundary.

B21-24 to 60 inches; dark brown (7.5YR 3/4) silt loam, strong brown (7.5YR 5/6) dry; weak very coarse, coarse, and medium subangular blocky structure; hard, friable, slightly sticky and nonplastic; weakly smeary; few fine and very fine roots; common fine and very fine tubular pores; medium acid.

The content of coarse fragments in the solum ranges from 0 to 10 percent. The solum is more than 60 inches thick. The profile is medium acid or strongly acid throughout.

The A horizon has hue of 7.5YR or 10YR when moist or dry, and it has value and chroma of 2 or 3 when moist. The B2 horizon has hue of 7.5YR or 10YR when moist or dry, and it has value and chroma of 3 or 4 when moist. The A horizon and the upper part of the B2 horizon have 0 to 25 percent soft concretions.

Grehalem Series

The Grehalem series consists of very deep, well drained soils on flood plains. Grehalem soils formed in alluvium derived from basic igneous and sedimentary rock. Slope is 0 to 3 percent. Elevation is 10 to 100 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, the average growing season is 180 to 220 days, and the average frost-free season is 150 to 200 days.

These soils are fine-loamy, mixed, nonacid, mesic Typic Udifluvents.

Typical pedon of Grehalem silt loam, in Grays Harbor County, 3 miles south of Copalis Crossing, about 900 feet east and 1,900 feet north of the southwest corner of sec. 4, T. 18 N., R. 11 W.

Ap-0 to 8 inches; dark brown (10YR 3/3) silt loam, light brownish gray (2.5Y 6/2) dry; moderate fine subangular blocky structure; hard, friable, sticky and plastic; many fine roots; many fine and medium tubular pores; medium acid; clear smooth boundary.

C1-8 to 40 inches; dark brown (10YR 3/3) silty clay loam, pale yellow (2.5Y 7/4) dry; moderate fine subangular blocky structure; very hard, friable, sticky and plastic; common fine roots; many fine and medium tubular pores; thin lenses of loose sand and loamy sand; medium acid; gradual wavy boundary.

C2-40 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam, pale yellow (2.5Y 7/4) dry; weak medium subangular blocky structure; very hard, friable, sticky and plastic; many fine tubular pores; thin lenses of loose sand; medium acid.

The control section is dominantly silty clay loam and is 28 to 35 percent clay. There are thin, discontinuous lenses of sand and clay throughout.

The A horizon has hue of 2.5Y or 5Y when dry, value of 3 or 4 when moist, and chroma of 2 or 3 when moist and 2 to 4 when dry.

The C horizon has hue of 2.5Y or 5Y when dry, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 3 or 4 when moist or dry. It is mainly silty clay loam, but it is weakly stratified with very fine sandy loam to clay loam.

Halbert Series

The Halbert series consists of shallow, poorly drained soils on outwash plains on uplands. Halbert soils formed in glaciolacustrine sediment deposited over glacial outwash. Slope is 0 to 10 percent. Elevation is 50 to 500 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 48 degrees F, and the average growing season is 180 to 220 days.

These soils are loamy, mixed, acid, mesic, shallow Histic Placaquepts.

Typical pedon of Halbert muck, 0 to 10 percent slopes, in Grays Harbor County, 1 mile east of Pacific Beach, about 1,200 feet west and 400 feet north of the southeast corner of sec. 16, T. 20 N., R. 12 W.

O1-16 to 11 inches; accumulation of needles and twigs.

O2-11 inches to 0; black (10YR 2/1) muck (sapric material), dark gray (10YR 4/1) dry; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many very fine and fine roots and common medium and coarse roots; less than 5 percent fibers; common very fine interstitial pores; extremely acid; clear smooth boundary.

A1-0 to 5 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; common fine distinct grayish brown (2.5Y 5/2) mottles; moderate fine subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine, fine, and medium roots; many very fine tubular and interstitial pores; extremely acid; gradual wavy boundary.

B21g-5 to 15 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; common fine and medium prominent dark reddish brown (2.5YR 3/4) mottles; moderate medium subangular blocky structure; hard, friable, sticky and plastic; common very fine tubular and interstitial pores; very strongly acid; abrupt smooth boundary.
B22irm-15 to 16 inches; dark reddish brown (2.5YR 3/4) indurated continuous iron pan, yellowish red (5YR 4/6) dry; very hard and very firm; very strongly acid; abrupt wavy boundary.
C1g-16 to 23 inches; grayish brown (2.5Y 5/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; common fine prominent dark reddish brown (2.5YR 3/4) mottles; massive; slightly hard, friable, sticky and plastic; common very fine tubular pores; very strongly acid; clear smooth boundary.
IIC2g-23 to 60 inches; olive gray (5Y 5/2) extremely gravelly sandy loam, light gray (5Y 7/2) dry; massive; soft, very friable, nonsticky and nonplastic; common very fine tubular pores; 65 percent hard rounded pebbles; very strongly acid.

The soil is saturated during all but the driest months of the year unless it is artificially drained. Depth to the B22irm horizon ranges from 20 to 40 inches. The mineral soil is extremely acid or very strongly acid. The control section is 30 to 35 percent clay. The histic epipedon is 8 to 16 inches thick.

The A1 horizon has value of 2 or 3 when moist and 3 or 4 when dry, and it has chroma of 1 or 2 when moist or dry.

The B21g horizon has hue of 10YR or 2.5Y when moist or dry, value of 5 or 6 when dry, and chroma of 1 or 2 when moist or dry. The B22irm horizon has hue of 2.5YR or 5YR when moist or dry.

The C1g horizon has hue of 2.5Y or 5Y when moist or dry, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 0 to 2 when moist or dry. It is silty clay loam or silty clay. The content of coarse fragments ranges from 0 to 10 percent.

The IIC2g horizon has the same color range as the C1g horizon. It is very gravelly sandy loam, extremely gravelly loam, or extremely gravelly sandy loam.

Hoquiam Series

The Hoquiam series consists of deep, well drained soils on ground moraines on uplands. Hoquiam soils formed in old alluvium deposited over glacial drift. Slope is 1 to 65 percent. Elevation is 100 to 900 feet. The average annual precipitation is 80 to 130 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Hoquiam silt loam, 8 to 30 percent slopes, in Grays Harbor County, 12 miles northwest of Montesano, about 1,300 feet north and 1,300 feet east of the southwest corner of sec. 29, T. 19 N., R. 8 W.

O1-3 inches to 0; accumulation of moss, twigs, and leaves.
A1-0 to 15 inches; dark reddish brown (5YR 3/3) silt loam, dark brown (7.5YR 4/4) dry; strong medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; many very fine tubular and interstitial pores; 10 percent rounded pebbles; very strongly acid; clear wavy boundary.
B21-15 to 26 inches; reddish brown (5YR 4/4) silt loam, strong brown (7.5YR 5/6) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine, medium, and coarse roots; many very fine tubular pores; 10 percent rounded pebbles; very strongly acid; clear wavy boundary.
B22-26 to 43 inches; dark brown (7.5YR 4/4) gravelly silt loam, yellowish brown (10YR 5/6) dry; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; common very fine tubular pores; 20 percent rounded pebbles; very strongly acid; clear wavy boundary.
IIB23-43 to 51 inches; dark brown (7.5YR 4/4) gravelly sandy loam, yellowish brown (10YR 5/6) dry; weak very fine subangular blocky structure; hard, friable, nonsticky and nonplastic; few fine roots; few very fine interstitial pores; 30 percent rounded and subrounded pebbles; very strongly acid; clear smooth boundary.
IICr-51 inches; dark brown (7.5YR 4/4) dense glacial drift that crushes to extremely gravelly loamy sand, light yellowish brown (10YR 6/4) dry; massive; compacted; very hard, very firm, nonsticky and nonplastic; 75 percent rounded and subrounded pebbles that have dark red (2.5YR 3/6) patchy stains; weakly cemented by iron and manganese; very strongly acid.

The solum is 40 to 55 inches thick. The 10- to 40-inch control section is 20 to 35 percent clay and 5 to 20 percent coarse fragments. The profile is very strongly acid or strongly acid throughout. The umbric epipedon is 10 to 20 inches thick.

The A1 horizon has hue of 5YR or 7.5YR when moist and 7.5YR or 10YR when dry, value of 4 or 5 when dry, and chroma of 2 or 3 when moist and 2 to 4 when dry.

The B2 horizon has hue of 5YR or 7.5YR when moist and 7.5YR or 10YR when dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is silt loam, gravelly silt loam, silty clay loam, or gravelly silty clay loam and is 5 to 35 percent pebbles.

The IIB23 horizon has hue of 7.5YR or 10YR when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is gravelly sandy loam, very gravelly sandy loam, gravelly loam, or very gravelly loam and is 20 to 45 percent pebbles.

The IICr horizon has hue of 7.5YR or 10YR when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is dense glacial till that crushes to extremely gravelly loamy sand or very gravelly sand and is 50 to 80 percent coarse fragments.

Humptulips Series

The Humptulips series consists of very deep, somewhat excessively drained soils on flood plains. Humptulips soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 10 to 50 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 49 degrees F, the average growing season is 180 to 220 days, and the average frost-free season is 150 to 200 days.

These soils are coarse-loamy over sandy or sandy-skeletal, mixed, nonacid, mesic Typic Udifluvents.

Typical pedon of Humptulips silt loam, in Grays Harbor County, 10 miles north of Montesano, about 900 feet east and 1,400 feet north of the southwest corner of sec. 22, T. 19 N., R. 8 W.

Ap-0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common medium and fine roots; many fine interstitial pores; neutral; abrupt smooth boundary.

C1-8 to 12 inches; dark brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; hard; firm, slightly sticky and nonplastic; many fine and medium roots; few fine interstitial and tubular pores; thin strata of loose sand and loamy sand; neutral; clear smooth boundary.

C2-12 to 26 inches; dark yellowish brown (10YR 4/4) silt loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few fine roots; few fine interstitial and tubular pores; thin strata of loose sand and loamy sand; neutral; clear smooth boundary.

IIC3-26 to 60 inches; dark yellowish brown (10YR 4/4) extremely gravelly sand, grayish brown (2.5Y 5/2) dry; single grain; loose; few fine roots; 75 percent hard waterworn pebbles of graywacke and basalt; neutral.

Hue is 10YR or 2.5Y when moist or dry. The upper part of the control section is silt loam that is less than 18 percent clay, 15 to 40 percent fine and coarse sand, and less than 5 percent rock fragments.

The C horizon is silt loam stratified with fine sandy loam to sand. The IIC horizon is extremely gravelly sand or extremely gravelly loamy sand. The Ap and C horizons have value of 4 to 6 when dry and chroma of 2 to 4 when moist and 2 to 6 when dry.

Ilwaco Series

The Ilwaco series consists of very deep, well drained soils on uplands. Ilwaco soils formed in material weathered from sandstone. Slope is 1 to 65 percent. Elevation is sea level to 1,000 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is 46 to 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Ilwaco silt loam, 1 to 8 percent slopes, in Pacific County, 5 miles west of South Bend, about 1,800 feet north and 2,200 feet west of the southeast corner of sec. 25, T. 14 N., R. 10 W.

O1-2 inches to 0; accumulation of needles, twigs, moss, and roots.

A11-0 to 11 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine granular structure; slightly hard, very friable, nonsticky and slightly plastic; weakly smeary; many very fine and fine roots and common medium and coarse roots; many very fine and fine interstitial pores; medium acid; gradual wavy boundary.

A12-11 to 17 inches; dark brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common fine and very fine roots and few coarse roots; many very fine and fine tubular pores; strongly acid; clear wavy boundary.

B21-17 to 32 inches; dark yellowish brown (10YR 4/4) silt loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots; many very fine and fine tubular pores; strongly acid; gradual wavy boundary.

B22-32 to 60 inches; dark yellowish brown (10YR 4/6) silt loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; many very fine and fine tubular pores; medium acid.

The solum is 50 inches to more than 60 inches thick. The 10- to 40-inch control section is 20 to 27 percent clay and 0 to 15 percent fragments of soft sandstone. The profile is very strongly acid to medium acid

throughout. The umbric epipedon is 12 to 20 inches thick.

The A horizon has hue of 10YR or 7.5YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 2 to 4 when dry.

The B horizon has hue of 10YR or 7.5YR when moist or dry, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 4 to 6 when moist or dry. It is silt loam or loam.

Juno Series

The Juno series consists of very deep, somewhat excessively drained soils on flood plains. Juno soils formed in alluvium derived from glacial sediment. Slope is 0 to 3 percent. Elevation is 100 to 300 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are sandy-skeletal, mixed, mesic Typic Udifluvents.

Typical pedon of Juno sandy loam, in Grays Harbor County, 5 miles north of Satsop, about 400 feet east and 1,400 feet south of the northwest corner of sec. 7, T. 18 N., R. 6 W.

A1-0 to 12 inches; very dark grayish brown (10YR 3/2) sandy loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; few very fine interstitial pores; 10 percent waterworn pebbles; medium acid; abrupt smooth boundary.

IIC1-12 to 18 inches; dark grayish brown (10YR 4/2) gravelly sand, light brownish gray (10YR 6/2) dry; single grain; loose; few very fine roots; 20 percent waterworn pebbles; medium acid; clear smooth boundary.

IIC2-18 to 60 inches; dark grayish brown (10YR 4/2) and yellowish brown (10YR 5/6) extremely gravelly sand, light brownish gray (10YR 6/2) and brownish yellow (10YR 6/6) dry; single grain; loose; 80 percent waterworn pebbles; slightly acid.

The solum is 10 to 20 inches thick.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 3 or 4 when moist, and chroma of 2 or 3 when moist or dry. It is strongly acid or medium acid.

The IIC1 horizon is slightly acid or medium acid.

The IIC2 horizon is extremely gravelly sand or very gravelly sand.

Katula Series

The Katula series consists of moderately deep, well drained soils on uplands. Katula soils formed in material weathered from basalt. Slope is 5 to 90 percent. Elevation is 1,100 to 2,200 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial-skeletal, mesic Andic Haplumbrepts.

Typical pedon of Katula very cobbly loam, 65 to 90 percent slopes, in Pacific County, 4 miles southwest of Frances, about 900 feet east and 2,500 feet south of the northwest corner of sec. 27, T. 12 N., R. 7 W.

O1-7 to 2 inches; accumulation of Douglas-fir and western hemlock needles and twigs.

O2-2 inches to 0; decomposed needles and twigs.

A11-0 to 3 inches; dark reddish brown (5YR 3/2) very cobbly loam, reddish brown (5YR 4/4) dry; strong medium and fine granular structure; slightly hard, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine roots, common coarse roots, and few medium roots; many fine tubular and interstitial pores; 40 percent cobbles and 20 percent pebbles; medium acid; clear smooth boundary.

A11-3 to 13 inches; dark reddish brown (5YR 3/3) extremely cobbly loam, yellowish red (5YR 4/6) dry; strong medium and fine granular structure; slightly hard, very friable, nonsticky and slightly plastic; weakly smeary; many very fine and fine roots and common medium and coarse roots; many fine tubular and interstitial pores; 45 percent cobbles and 20 percent pebbles; medium acid; gradual smooth boundary.

B21-13 to 18 inches; dark reddish brown (5YR 3/4) extremely cobbly clay loam, yellowish red (5YR 4/6) dry; moderate very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine and few fine roots; common fine tubular pores; 45 percent cobbles and 20 percent pebbles; medium acid; gradual smooth boundary.

B22-18 to 32 inches; dark brown (7.5YR 4/4) extremely cobbly clay loam, strong brown (7.5YR 5/6) dry; moderate very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and few very fine roots; common fine tubular and interstitial pores; 70 percent cobbles and 10 percent pebbles; medium acid; abrupt smooth boundary.

R-32 inches; basalt, fractured in the upper part.

Depth to basalt ranges from 20 to 40 inches. The profile averages 60 to 80 percent angular cobbles, pebbles, and stones. The percentage of rock fragments increases with depth.

The A horizon has hue of 5YR, 7.5YR, or 10YR when moist or dry, value of 2 or 3 when moist and 2 to 4 when dry, and chroma of 2 or 3 when moist and 3 to 6 when

dry. It is 35 to 45 percent cobbles and 20 to 45 percent pebbles.

The B horizon has hue of 5YR, 7.5YR, or 10YR when moist or dry, value of 3 to 5 when moist and 4 or 5 when dry, and chroma of 2 to 6 when moist and 4 to 6 when dry. It is extremely cobbly clay loam or extremely cobbly loam.

Knappton Series

The Knappton series consists of deep, well drained soils on uplands. Knappton soils formed in material weathered from basalt. Slope is 8 to 90 percent. Elevation is 100 to 1,800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Knappton silt loam, 8 to 30 percent slopes, in Pacific County, 5 miles northeast of Nemah, about 750 feet east and 200 feet south of the northwest corner of sec. 8, T. 12 N., R. 9 W.

O1-1 inch to 0; accumulation of needles, twigs, and moss.

A11-0 to 2 inches; dark brown (7.5YR 3/2) silt loam, brown (7.5YR 5/2) dry; moderate fine and very fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many very fine and common fine roots; many fine interstitial pores; strongly acid; gradual smooth boundary.

A12-2 to 12 inches; dark reddish brown (5YR 3/3) silt loam, reddish brown (5YR 5/3) dry; moderate fine and very fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common fine and very fine roots; many very fine tubular pores; 10 percent angular basalt pebbles; medium acid; gradual wavy boundary.

B21-12 to 24 inches; reddish brown (5YR 4/4) gravelly silt loam, reddish brown (5YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; weakly smeary; common fine and medium roots and few coarse roots; common very fine tubular pores; 20 percent angular basalt pebbles; medium acid; gradual wavy boundary.

B22-24 to 28 inches; dark brown (7.5YR 4/4) gravelly silty clay loam, brown (7.5YR 5/4) dry; weak medium and coarse angular blocky structure; slightly hard, friable, sticky and plastic; weakly smeary; few fine and medium roots; common fine and medium tubular pores; 20 percent angular basalt pebbles; medium acid; gradual wavy boundary.

B23-28 to 43 inches; strong brown (7.5YR 5/6) gravelly silty clay loam, reddish yellow (7.5YR 6/6) dry; weak medium and coarse angular blocky structure; slightly hard, friable, sticky and plastic; weakly smeary; few fine and medium roots; common fine and medium tubular pores, 25 percent angular basalt pebbles; medium acid; clear wavy boundary.

R-43 inches; highly weathered, fractured basalt; few very fine roots in fractures.

The depth to fractured basalt ranges from 40 to 60 inches or more. The 10- to 40-inch control section is 20 to 40 percent clay and 15 to 35 percent pebbles. The profile is strongly acid or medium acid throughout. The umbric epipedon is 10 to 15 inches thick.

The A horizon has hue of 5YR, 7.5YR, or 10YR when moist or dry, value of 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has hue of 5YR, 7.5YR, or 10YR when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is gravelly silt loam or gravelly silty clay loam.

Lates Series

The Lates series consists of moderately deep, well drained soils on mountains. Lates soils formed in material weathered from basalt. Slope is 8 to 90 percent. Elevation is 1,800 to 2,700 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 44 degrees F, and the average growing season is 150 to 180 days.

These soils are medial, frigid Andic Haplumbrepts.

Typical pedon of Lates silt loam, 8 to 30 percent slopes, in Wahkiakum County, 14 miles northeast of Cathlamet, about 300 feet south and 750 feet east of the northwest corner of sec. 4, T. 10 N., R. 5 W.

A11-0 to 5 inches; very dark brown (10YR 2/2) silt loam, dark brown (10YR 3/3) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common medium, fine, and very fine roots; many fine and very fine tubular pores; 1 to 2 percent pebble-sized fragments of basalt; very strongly acid; abrupt wavy boundary.

A12-5 to 14 inches; black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) dry; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many fine and common coarse roots; common medium and fine tubular pores; 5 percent pebble-sized fragments of basalt; very strongly acid; abrupt smooth boundary.

B2-14 to 35 inches; dark brown (10YR 4/3) gravelly loam, yellowish brown (10YR 5/4) dry; weak medium and fine subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; weakly smeary; common fine and very fine roots; common medium, fine, and very fine tubular pores;

20 percent pebble-sized fragments of basalt; strongly acid; abrupt irregular boundary.
R-35 inches; fractured basalt; few fine and very fine roots in fractures.

Depth to fractured basalt is 20 to 40 inches.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 1 or 2 when moist and 2 to 4 when dry.

The B horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 4 to 6 when dry.

Lebam Series

The Lebam series consists of very deep, well drained soils on uplands. Lebam soils formed in material weathered from siltstone or very fine sandstone. Slope is 1 to 30 percent. Elevation is 20 to 1,100 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is 46 to 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Lebam silt loam, 1 to 8 percent slopes, in Pacific County, 3 miles southwest of Nemah, about 1,700 feet west and 300 feet south of the northeast corner of sec. 25, T. 12 N., R. 10 W.

O1-2 inches to 0; accumulation of needles, twigs, and moss.
A1-0 to 11 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine and medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; many fine and common medium roots; many fine interstitial pores; very strongly acid; clear wavy boundary.
A3-11 to 21 inches; dark yellowish brown (10YR 3/4) silt loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common fine and very fine roots; many fine and very fine tubular pores; strongly acid; gradual wavy boundary.
B21-21 to 29 inches; dark yellowish brown (10YR 4/4) silty clay loam, brownish yellow (10YR 6/6) dry; moderate fine subangular blocky structure; hard, friable, sticky and plastic; weakly smeary; common fine and very fine roots; many fine and very fine tubular pores; strongly acid; gradual wavy boundary.
B22-29 to 60 inches; dark yellowish brown (10YR 4/6) silty clay loam, brownish yellow (10YR 6/6) dry; moderate medium and coarse subangular blocky structure; hard, friable, sticky and plastic; weakly smeary; few fine and very fine tubular pores; 5 percent fragments of soft siltstone; strongly acid.

The solum is 40 inches to more than 60 inches thick. The 10- to 40-inch control section averages 35 to 55 percent clay and less than 15 percent fragments of soft siltstone. The umbric epipedon is 10 to 18 inches thick.

The A1 horizon has hue of 10YR or 7.5YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The A3 horizon has hue of 10YR or 7.5YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 4 or 5 when moist or dry.

The B horizon has hue of 10YR or 7.5YR when moist or dry, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 4 to 6 when moist or dry. It is silty clay loam or silty clay.

Le Bar Series

The Le Bar series consists of very deep, well drained soils on low terraces and benches. Le Bar soils formed in old alluvium. Slope is 1 to 65 percent. Elevation is 100 to 800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Typic Dystrandepts.

Typical pedon of Le Bar silt loam, 1 to 8 percent slopes, in Grays Harbor County, 2 miles northwest of Satsop, about 2,400 feet west and 600 feet north of the southeast corner of sec. 24, T. 18 N., R. 7 W.

O1-1 inch to 0; accumulation of needles, twigs, and moss.
A1-0 to 5 inches; dark brown (7.5YR 3/2) silt loam, dark brown (7.5YR 4/4) dry; strong fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many very fine, medium, and coarse roots; many very fine interstitial pores; 10 percent medium firm iron-manganese concretions; very strongly acid; clear smooth boundary.
A3-5 to 12 inches; dark reddish brown (5YR 3/3) silt loam, brown (7.5YR 5/4) dry; strong fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; many very fine tubular pores; very strongly acid; gradual smooth boundary.
B21-12 to 25 inches; dark brown (7.5YR 4/4) silt loam, brown (7.5YR 5/4) dry; strong fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; common very fine tubular pores; very strongly acid; gradual smooth boundary.
B22-25 to 45 inches; dark brown (7.5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; strong fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; common very fine tubular pores; very strongly acid; gradual smooth boundary.

B23-45 to 60 inches; reddish brown (5YR 4/4) silt loam, light brown (7.5YR 6/4) dry; strong fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; common very fine tubular pores; very strongly acid.

The solum is more than 40 inches thick. It is 20 to 27 percent clay and 0 to 15 percent pebbles.

The A horizon has hue of 7.5YR or 5YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist.

The B horizon has hue of 5YR or 7.5YR when moist and 7.5YR or 10YR when dry, and it has value of 3 or 4 when moist and 5 or 6 when dry.

Lyre Series

The Lyre series consists of very deep, somewhat excessively drained soils on terraces and plains. Lyre soils formed in glacial outwash. Slope is 0 to 8 percent. Elevation is 50 to 300 feet. The average annual precipitation is 60 to 90 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial-skeletal, mesic Andic Xerochrepts.

Typical pedon of Lyre very gravelly loamy sand, 0 to 8 percent slopes, in Grays Harbor County, 2 miles east of Elma, about 1,600 feet east of the southwest corner of sec. 30, T. 18 N., R. 5 W.

O1-3 inches to 1 inch; accumulation of needles, twigs, and leaves.

O2-1 inch to 0; decomposed needles, twigs, and leaves.

B21hir-0 to 7 inches; dark reddish brown (5YR 3/3) very gravelly loamy sand, brown (7.5YR 5/4) dry; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine roots and common medium and coarse roots; common very fine interstitial pores; 50 percent waterworn pebbles; medium acid; clear wavy boundary.

B22ir-7 to 23 inches; dark reddish brown (5YR 3/4) very gravelly sandy loam, strong brown (7.5YR 5/6) dry; weak very fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common very fine roots; common very fine interstitial pores; 60 percent waterworn pebbles; medium acid; gradual wavy boundary.

B3-23 to 35 inches; dark brown (7.5YR 4/4) very gravelly sand, yellowish brown (10YR 5/4) dry; single grain; loose, nonsticky and nonplastic; common very fine roots; 60 percent waterworn pebbles; medium acid; clear wavy boundary.

IIC-35 to 60 inches; dark grayish brown (10YR 4/2) extremely gravelly sand, grayish brown (10YR 5/2) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; 65 percent waterworn pebbles; medium acid.

The control section is 55 to 70 percent coarse fragments, dominantly pebbles. The profile is strongly acid to medium acid throughout.

The B2hir horizon has hue of 5YR, 7.5YR, or 10YR when moist or dry, value of 4 or 5 when dry, and chroma of 2 to 4 when moist or dry. The B2ir horizon has hue of 5YR or 7.5YR when moist or dry, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is very gravelly sandy loam or extremely gravelly sandy loam.

The B3 horizon has hue of 10YR or 7.5YR when moist or dry, and it has value and chroma of 3 to 5 when moist or dry. It is very gravelly loamy sand or very gravelly sand.

The IIC horizon has hue of 10YR to 2.5Y when moist or dry, value of 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. It is extremely gravelly sand or extremely gravelly coarse sand.

Lyre Variant

The Lyre Variant consists of moderately deep, moderately well drained soils on benches and valley floors. Lyre Variant soils formed in glacial drift. Slope is 0 to 3 percent. Elevation is 100 to 300 feet. The average annual precipitation is 60 to 75 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial-skeletal, mesic Andic Xerochrepts.

Typical pedon of Lyre Variant very gravelly sandy loam, in Grays Harbor County, 1 mile west of McCleary, about 2,200 feet east and 300 feet north of the southwest corner of sec. 10, T. 18 N., R. 5 W.

Ap-0 to 9 inches; dark brown (7.5YR 3/2) very gravelly sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many very fine roots; many very fine interstitial pores; 60 percent rounded pebbles; medium acid; clear smooth boundary.

B2-9 to 19 inches; dark reddish brown (5YR 3/4) very gravelly sandy loam, brown (7.5YR 5/4) dry; weak very fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; few very fine tubular pores; 60 percent rounded pebbles; medium acid; clear wavy boundary.

B3-19 to 28 inches; dark brown (7.5YR 4/4) very gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak very fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; weakly

smeary; 60 percent rounded pebbles; medium acid; abrupt wavy boundary.

IICr-28 inches; dark brown (7.5YR 4/4) dense glacial drift that crushes to extremely gravelly sandy loam, light brownish gray (10YR 6/2) dry; massive; very hard, very firm, nonsticky and nonplastic; strongly compacted; 75 percent rounded pebbles; slightly acid.

The solum is 20 to 40 inches thick. The content of pebbles in the control section exceeds 40 percent and averages less than 75 percent. Reaction ranges from strongly acid to slightly acid, and acidity decreases with depth.

The A horizon has hue of 5YR or 7.5YR when moist and 7.5YR or 10YR when dry, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has hue of 5YR or 7.5YR when moist and 7.5YR or 10YR when dry, value of 3 or 4 when moist, and chroma of 2 to 4 when moist or dry. It is very gravelly sandy loam or very gravelly loam.

The IICr horizon has hue of 7.5YR or 10YR when moist and 10YR or 2.5Y when dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist or dry.

Lytell Series

The Lytell series consists of deep, well drained soils on uplands. Lytell soils formed in material weathered from siltstone or very fine sandstone. Slope is 8 to 90 percent. Elevation is 20 to 1,500 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Lytell silt loam, 30 to 65 percent slopes, in Wahkiakum County, 6 miles northeast of Rosburg, about 1,050 feet west and 375 feet north of the southeast corner of sec. 10, T. 10 N., R. 7 W.

O1-3 inches to 1 inch; twigs, needles, and decayed tree limbs.

O2-1 inch to 0; decomposed organic matter.

A1-0 to 11 inches; dark brown (7.5YR 3/2) silt loam, dark brown (10YR 3/3) dry; strong medium and fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; common fine and very fine roots and few coarse and medium roots; few very fine tubular pores and many micro interstitial pores; 20 percent angular fragments of soft siltstone; very strongly acid; gradual smooth boundary.

A3-11 to 17 inches; dark brown (7.5YR 3/2) silty clay loam, dark brown (10YR 3/3) dry; moderate coarse and medium subangular blocky structure and strong medium and fine granular; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common medium and fine roots; common medium and fine tubular pores; 25 percent angular fragments of soft siltstone; very strongly acid; clear wavy boundary.

B21-17 to 25 inches; dark yellowish brown (10YR 3/4) silty clay loam, dark yellowish brown (10YR 4/4) dry; weak medium and fine subangular blocky structure; slightly hard, firm, sticky and plastic; weakly smeary; few fine and very fine roots; common medium and fine tubular pores; 60 percent angular fragments of soft siltstone; very strongly acid; clear wavy boundary.

B22-25 to 41 inches; dark yellowish brown (10YR 3/4) silty clay loam, yellowish brown (10YR 5/4) dry; moderate coarse, medium, and fine subangular blocky structure; slightly hard, firm, sticky and plastic; weakly smeary; few very fine and fine roots; many fine and very fine tubular pores; 80 percent angular fragments of soft siltstone; strongly acid; clear wavy boundary.

B3-41 to 50 inches; dark yellowish brown (10YR 3/6) silty clay loam, yellowish brown (10YR 5/6) dry; weak very fine subangular blocky structure; slightly hard, firm, sticky and plastic; weakly smeary; few very fine roots; many micro interstitial pores; 80 percent soft angular pebbles, cobbles, and stone-sized fragments of siltstone; very strongly acid; abrupt smooth boundary.

Cr-50 inches; partly consolidated siltstone.

Solum thickness and depth to partly consolidated siltstone are 40 to 60 inches or more. The 10- to 40-inch control section is 27 to 35 percent clay. The profile is strongly acid to extremely acid.

The A horizon has hue of 10YR or 7.5YR when moist or dry, value of 2 or 3 when moist, and chroma of 2 or 3 when moist or dry. It is 20 to 35 percent fragments of soft siltstone.

The B horizon has value of 3 or 4 when moist and 4 to 6 when dry, and it has chroma of 4 to 6 when moist or dry. It is silty clay loam or clay loam and is 45 to 85 percent soft siltstone pebbles, cobbles, and stone-sized fragments.

Melbourne Series

The Melbourne series consists of very deep, well drained soils on uplands. Melbourne soils formed in material weathered from siltstone, shale, and fine grained sandstone. Slope is 1 to 65 percent. Elevation is 250 to 700 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season is 200 to 240 days.

These soils are fine, mixed, mesic Ultic Haploxeralfs.

Typical pedon of Melbourne silt loam, 8 to 30 percent slopes, in Grays Harbor County, 6 miles northwest of Oakville, about 2,400 feet west and 1,600 feet north of the southeast corner of sec. 8, T. 16 N., R. 5 W.

O1-1 inch to 0; accumulation of needles, moss, and bark.
A1-0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; strong very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine, medium, and coarse roots and common very fine roots; many very fine interstitial pores; medium acid; clear wavy boundary.
B1-10 to 19 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine, fine, and medium roots; common very fine tubular pores; strongly acid; gradual smooth boundary.
B21t-19 to 38 inches; dark brown (10YR 4/3) silty clay, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; common very fine tubular pores; few thin and moderately thick clay films on faces of peds and in pores; strongly acid; gradual smooth boundary.
B22t-38 to 60 inches; dark yellowish brown (10YR 4/4) silty clay, yellowish brown (10YR 5/4) dry; moderate fine subangular blocky structure; very hard, firm, sticky and plastic; few very fine roots; common very fine tubular pores; common thin and moderately thick clay films on faces of peds and in pores; strongly acid; clear smooth boundary.

The solum thickness ranges from 40 to 90 inches. Hue is 10YR or 7.5YR when moist or dry. The control section is 35 to 60 percent clay and is silty clay loam, silty clay, clay loam, or clay.

The A horizon has value of 2 or 3 when moist and 5 or 6 when dry, and it has chroma of 2 to 4 when moist or dry. It is slightly acid or medium acid.

The B2t horizon has value of 4 or 5 when moist and 5 or 6 when dry, and it has chroma of 3 or 4 when moist and 3 to 8 when dry. It is clay loam, silty clay loam, silty clay, or clay and is medium acid or strongly acid.

Montesa Series

The Montesa series consists of very deep, somewhat poorly drained soils on benches and alluvial fans. Montesa soils formed in material derived from sedimentary and igneous sediment. Slope is 1 to 8 percent. Elevation is 25 to 300 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are coarse-loamy, mixed, mesic Aquic Dystrochrepts.

Typical pedon of Montesa silt loam, 1 to 8 percent slopes, in Wahkiakum County, 1 mile northwest of Skamokawa, about 800 feet west and 1,300 feet south of the northeast corner of sec. 7, T. 9 N., R. 6 W.

Ap-0 to 10 inches; dark brown (7.5YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many medium and fine roots; many very fine interstitial pores; very strongly acid; clear wavy boundary.
A12-10 to 18 inches; dark brown (7.5YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; moderate fine, medium, and coarse subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common medium, fine, and very fine roots; many very fine interstitial pores; very strongly acid; abrupt wavy boundary.
B2-18 to 25 inches; strong brown (7.5YR 5/6) fine sandy loam, reddish yellow (7.5YR 6/6) dry; when rubbed the horizon is dark brown (7.5YR 3/4), strong brown (7.5YR 5/6) dry; common medium distinct red (2.5YR 4/8) and light brownish gray (10YR 6/2) mottles, yellowish red (5YR 5/8) and light gray (10YR 7/2) dry; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few coarse and medium roots; common fine and very fine interstitial pores; strongly acid; abrupt wavy boundary.
C-25 to 60 inches; pale brown (10YR 6/3) silt loam, very pale brown (10YR 7/3) dry; when rubbed the horizon is dark yellowish brown (10YR 4/4), light brownish gray (10YR 6/2) dry; common large prominent red (2.5YR 4/8) mottles, yellowish red (5YR 5/8) dry; massive; slightly hard, very friable, nonsticky and slightly plastic; few fine and very fine roots; few fine and very fine interstitial pores; medium acid.

The profile is medium acid to very strongly acid. The control section is 10 to 15 percent clay and is less than 15 percent rock fragments. Depth to mottles is 15 to 24 inches.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 2 to 4 when moist or dry.

The B horizon has hue of 7.5YR, 10YR, or 2.5Y when moist or dry, value of 3 to 5 when moist and 5 or 6 when dry, and chroma of 2 to 6 when moist or dry. It is silt loam, loam, or fine sandy loam.

The C horizon has hue of 10YR or 2.5Y when moist or dry, value of 4 to 6 when moist and 4 to 7 when dry, and chroma of 2 to 4 when moist or dry. In some places the C horizon is layers and lenses of loamy sand to silty clay loam below a depth of 40 inches.

Mopang Series

The Mopang series consists of very deep, well drained soils on uplands. Mopang soils formed in glaciofluvial sediment. Slope is 5 to 90 percent. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is 46 to 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Mopang silt loam, 5 to 30 percent slopes, in Grays Harbor County, 8 miles northwest of Hoquiam, about 800 feet east and 600 feet south of the northwest corner of sec. 24, T. 18 N., R. 11 W.

O1-4 to 2 inches; undecomposed western hemlock needles, twigs, and moss.
O2-2 inches to 0; decomposed needles and twigs.
A1-0 to 6 inches; dark reddish brown (5YR 3/2) silt loam, dark brown (7.5YR 4/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; many fine interstitial pores; 5 percent rounded pebbles; extremely acid; clear wavy boundary.
B21-6 to 21 inches; dark reddish brown (5YR 3/3) silty clay loam, brown (7.5YR 5/4) dry; weak fine and medium subangular blocky structure; hard, firm, sticky and slightly plastic; weakly smeary; common fine, medium, and coarse roots; many fine tubular pores; 5 percent rounded pebbles; extremely acid; gradual wavy boundary.
B22-21 to 43 inches; dark brown (7.5YR 4/4) silty clay loam, reddish yellow (7.5YR 6/6) dry; weak fine and medium subangular blocky structure; hard, firm, sticky and plastic; weakly smeary; few fine and medium roots; common fine tubular pores; 10 percent rounded pebbles; very strongly acid; clear wavy boundary.
IIC1-43 to 51 inches; strong brown (7.5YR 5/6) very gravelly silt loam, reddish yellow (7.5YR 6/6) dry; massive; hard, firm, slightly sticky and slightly plastic; weakly smeary; few fine tubular pores; 40 percent rounded pebbles; very strongly acid; clear smooth boundary.
IIC2r-51 inches; strong brown (7.5YR 5/6) dense glacial drift that crushes to extremely gravelly silt loam, brownish yellow (10YR 6/6) dry; massive; very hard, very firm, slightly sticky and slightly plastic; weakly cemented by iron and manganese; 65 percent rounded pebbles; very strongly acid.

The solum thickness and depth to the IIC horizon range from 40 to 51 inches. The profile is extremely acid or very strongly acid throughout. Hue is 5YR or 7.5YR when moist. The control section is silty clay loam or silt loam. It is 5 to 15 percent coarse fragments and 25 to 35 percent clay. The umbric epipedon is 10 to 25 inches thick.

The A horizon has value of 3 or 4 when dry, and it has chroma of 2 to 5 when moist or dry.

The B horizon has value of 3 to 5 when moist and 5 to 7 when dry, and it has chroma of 3 to 6 when moist or dry. It is silty clay loam or silt loam.

The IIC horizon has value of 3 to 5 when moist and 5 to 7 when dry, and it has chroma of 4 to 6 when moist or dry. It is very gravelly silt loam or extremely gravelly silt loam.

Murnen Series

The Murnen series consists of very deep, well drained soils on mountains. Murnen soils formed in material weathered from basalt. Slope is 5 to 65 percent. Elevation is 1,800 to 2,700 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 44 degrees F, and the average growing season is 150 to 180 days.

These soils are medial, frigid Andic Haplumbrepts.

Typical pedon of Murnen silt loam, 5 to 30 percent slopes, in Wahkiakum County, 9 miles north of Skamokawa, about 1,000 feet west and 900 feet south of the northeast corner of sec. 4, T. 10 N., R. 6 W.

O1-1 inch to 0; partially decomposed leaf litter.
A11-0 to 3 inches; dark reddish brown (5YR 2/2) silt loam, dark reddish brown (5YR 3/2) dry; weak very fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine and fine roots and few medium and coarse roots; many very fine interstitial pores; very strongly acid; clear wavy boundary.
A12-3 to 8 inches; dark reddish brown (5YR 3/2) silt loam, dark brown (7.5YR 3/4) dry; weak fine and very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine and fine roots and few medium and coarse roots; many very fine interstitial pores; very strongly acid; clear wavy boundary.
A3-8 to 16 inches; dark brown (7.5YR 3/2) silt loam, dark brown (7.5YR 4/4) dry; moderate coarse and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; few very fine tubular pores; very strongly acid; clear wavy boundary.
B21-16 to 33 inches; dark yellowish brown (10YR 3/4) silt loam, yellowish brown (10YR 5/6) dry; moderate coarse and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; few very fine tubular pores; 5 percent pebbles; very strongly acid; clear *wavy* boundary.

B22-33 to 60 inches; yellowish brown (10YR 5/6) silt loam, brownish yellow (10YR 6/6) dry; moderate medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; few very fine tubular pores; 5 percent pebbles; very strongly acid.

The profile is strongly acid or very strongly acid throughout. The umbric epipedon is 10 to 20 inches thick.

The A horizon has hue of 5YR to 10YR when moist or dry, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 1 to 3 when moist and 2 to 4 when dry. It is 0 to 10 percent pebble-sized fragments of basalt.

The B horizon has hue of 5YR to 10YR when moist or dry, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 2 to 6 when moist or dry. It is 0 to 15 percent pebble-sized fragments of basalt.

Narel Series

The Narel series consists of deep, well drained soils on uplands. Narel soils formed in material weathered from sandstone. Slope is 8 to 90 percent. Elevation is sea level to 1,100 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Narel silt loam, 8 to 30 percent slopes, in Pacific County, 10 miles southeast of Ilwaco, about 50 feet west and 1,700 feet north of the southeast corner of sec. 11, T. 9 N., R. 10 W.

O1-5 inches to 0; accumulation of needles, moss, rotted wood, and twigs.

A11-0 to 3 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium granular structure; slightly hard, very friable, nonsticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; many very fine interstitial pores; 10 percent soft sandstone pebbles; extremely acid; abrupt wavy boundary.

A12-3 to 16 inches; dark brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) dry; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common medium roots and many fine and very fine roots; many fine tubular pores; 30 percent soft sandstone pebbles; very strongly acid; gradual wavy boundary.

B21-16 to 34 inches; dark brown (10YR 4/3) silt loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable; slightly sticky and slightly plastic; weakly smeary; common very fine roots; many fine tubular pores; 30 percent soft sandstone pebbles; very strongly acid; gradual wavy boundary.

B22-34 to 57 inches; dark yellowish brown (10YR 4/4) silt loam, light yellowish brown (10YR 6/4) dry; weak fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; common very fine tubular pores; 40 percent soft sandstone pebbles and 5 percent soft cobbles; very strongly acid; clear smooth boundary.

Cr-57 inches; partly consolidated sandstone.

Thickness of the solum and depth to paralithic contact range from 40 inches to more than 60 inches. The profile is strongly acid to extremely acid throughout. The umbric epipedon is 11 to 19 inches thick.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 2 to 4 when dry.

The B horizon has hue of 7.5YR or 10YR when moist or dry, value of 3 to 5 when moist and 4 to 6 when dry, and chroma of 3 or 4 when moist or dry. It is silt loam or loam and is 30 to 70 percent soft sandstone pebbles and cobbles.

Nemah Series

The Nemah series consists of very deep, poorly drained soils in depressional areas on terraces. Nemah soils formed in alluvium derived from mixed sediment. Slope is 0 to 2 percent. Elevation is 20 to 400 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are fine, mixed, acid, mesic Humic Haplaquepts.

Typical pedon of Nemah silty clay loam, in Grays Harbor County, 11 miles north of Montesano, about 1,350 feet east and 600 feet south of the northwest corner of sec. 23, T. 19 N., R. 8 W.

O1-4 to 2 inches; sphagnum moss, leaves, twigs, and stems.

O2-2 inches to 0; black (5YR 2/1) decomposed organic material.

A11-0 to 5 inches; black (5YR 2/1) silty clay loam, very dark gray (N 3/) dry; weak fine subangular blocky structure; hard, friable, sticky and plastic; many medium and fine roots; many fine tubular pores; about 20 percent organic matter; very strongly acid; clear smooth boundary.

A12-5 to 8 inches; very dark brown (10YR 2/2) silty clay, dark gray (10YR 4/1) dry; common medium faint grayish brown (2.5Y 5/2) and yellowish red (5YR 5/8) mottles; moderate fine subangular blocky structure; very hard, firm, very sticky and very plastic; common medium and fine roots; many fine

tubular and interstitial pores; about 10 percent organic matter; very strongly acid; clear wavy boundary.

B21g-8 to 13 inches; dark grayish brown (10YR 4/2) clay, light gray (2.5Y 7/2) dry; common coarse distinct grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/8) mottles; moderate medium prismatic structure; extremely hard, firm, very sticky and very plastic; few fine roots; many fine tubular and interstitial pores; very dark grayish brown (10YR 3/2) coatings on some faces of peds; very strongly acid; gradual wavy boundary.

B22g-13 to 26 inches; gray (N 6/) clay, light gray (2.5Y 7/2) dry; common coarse distinct strong brown (7.5YR 5/8) mottles; moderate medium prismatic structure; extremely hard, firm, very sticky and .plastic; few fine roots along prism faces; many fine tubular and interstitial pores; very dark grayish brown (10YR 3/2) coatings on some faces of peds; very strongly acid; gradual wavy boundary.

B23g-26 to 36 inches; gray (N 6/) clay, light gray (2.5Y 7/2) dry; common coarse distinct strong brown (7.5YR 5/8) mottles; weak medium prismatic structure; extremely hard, firm, very sticky and very plastic; few fine roots along prism faces; many fine tubular and interstitial pores; extremely acid; gradual wavy boundary.

IICg-36 to 60 inches; gray (N 6/) very gravelly clay, light gray (2.5Y 7/2) dry; common coarse distinct strong brown (7.5YR 5/8) mottles; massive; extremely hard, firm, very sticky and very plastic; 40 percent waterworn pebbles; very strongly acid.

Unless these soils are artificially drained, they are saturated most of the year. Depth to the IICg horizon ranges from 30 to 40 inches. Rooting depth is normally limited to less than 20 inches because of the high water table. The profile is very strongly acid or extremely acid throughout. The control section is dominantly clay and averages less than 25 percent coarse fragments.

The A horizon has hue of 5YR to N when moist or dry, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 0 to 2 when moist or dry. It has none to many distinct mottles.

The B2g horizon has hue of 10YR to N when moist or dry, value of 4 to 7 when moist or dry, and chroma of less than 2 when moist or dry. It is clay or silty clay and ranges from 45 to 60 percent clay.

The IICg horizon has the same color range as the B2g horizon. It is gravelly clay, very gravelly clay, gravelly silty clay, very gravelly silty clay, gravelly silty clay loam, or very gravelly silty clay loam and is 15 to 50 percent coarse fragments.

Netarts Series

The Netarts series consists of very deep, well drained soils on uplands. Netarts soils formed in sand. Slope is 3 to 12 percent. Elevation is 20 to 100 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are sandy, mixed, mesic Entic Haplorthods.

Typical pedon of Netarts fine sand, 3 to 12 percent slopes, in Pacific County, 1.5 miles south of Nahcotta, about 1,100 feet east and 300 feet south of the northwest corner of sec. 3, T. 11 N., R. 11 W.

O1-3 to 2 inches; accumulation of twigs, bark, needles, and branches.

O2-2 inches to 0; black (10YR 2/1) decomposed plant remains matted by roots.

A1-0 to 0.5 inch; dark brown (7.5YR 3/2) fine sand, very dark grayish brown (10YR 3/2) dry; single grain; loose; very strongly acid.

A2-0.5 to 3 inches; dark grayish brown (10YR 4/2) fine sand, dark gray (10YR 4/1) dry; single grain; loose; many medium and fine roots; very strongly acid; abrupt smooth boundary.

B21ir-3 to 12 inches; dark brown (7.5YR 4/4) fine sand, light brown (7.5YR 6/4) dry; single grain; loose; common medium fine yellowish red iron stains on soft nodules; many medium and fine roots; very strongly acid; abrupt irregular boundary.

B22ir-12 to 18 inches; dark brown (10YR 4/3) fine sand, brown (10YR 5/3) dry; single grain; loose; many medium and fine roots; medium acid; clear irregular boundary.

B3-18 to 25 inches; grayish brown (2.5Y 5/2) fine sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; common fine roots; medium acid; gradual irregular boundary.

C-25 to 60 inches; light brownish gray (2.5Y 6/2) fine sand, light gray (2.5Y 7/2) dry; single grain; loose; few fine roots to a depth of 40 inches; medium acid.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 3 or 4 when moist or dry, and chroma of 1 or 2 when moist or dry.

The B horizon has hue of 7.5YR, 10YR, or 2.5Y when moist or dry, value of 4 or 5 when moist, and chroma of 2 to 4 when moist.

The C horizon has value of 5 or 6 when moist.

In the Netarts soils in this survey area, the difference between the mean soil temperature in summer and the mean soil temperature in winter at a depth of 20 inches is greater than is defined as the range for the series. This difference, however, does not significantly affect use and management.

Newberg Series

The Newberg series consists of very deep, well drained soils on flood plains. Newberg soils formed in

alluvium. Slope is 0 to 3 percent. Elevation is 50 to 200 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 51 degrees F, the average growing season is 200 to 220 days, and the average frost-free season is 150 to 210 days.

These soils are coarse-loamy, mixed, mesic Fluventic Haploxerolls.

Typical pedon of Newberg silt loam, in Grays Harbor County, 3 miles southeast of Oakville, about 1,340 feet south and 1,500 feet east of the northwest corner of sec. 10,T. 15 N., R. 4 W.

A1-0 to 13 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many medium and fine roots; many fine and very fine interstitial and tubular pores; slightly acid; clear wavy boundary.

IIAC-13 to 18 inches; dark yellowish brown (10YR 3/4) sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common medium and fine roots; slightly acid; clear wavy boundary.

IIC1-18 to 36 inches; dark yellowish brown (10YR 4/4) sandy loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine roots; slightly acid; clear wavy boundary.

IIC2-36 to 60 inches; dark yellowish brown (10YR 4/4) loamy fine sand, light yellowish brown (2.5Y 6/4) dry; single grain; loose; few fine roots to a depth of 48 inches; slightly acid.

The control section averages loamy very fine sand or sandy loam and does not have contrasting textures. Depth to loamy fine sand that is less than 50 percent fine sand and coarser textured material ranges from 24 to 42 inches. The content of coarse fragments in the control section ranges from 0 to 15 percent. The profile is medium acid or slightly acid throughout. Hue is 7.5YR to 2.5Y when moist or dry.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The IIAC horizon has value of 3 or 4 when moist and 4 to 6 when dry, and it has chroma of 3 or 4 when moist or dry. It is sandy loam or silt loam.

The C horizon has value of 3 or 4 when moist and 4 to 6 when dry, and it has chroma of 2 to 4 when moist or dry. Gravelly, very gravelly, or sandy strata are in some places below a depth of 40 inches.

Newskah Series

The Newskah series consists of very deep, well drained soils on marine terraces and terrace escarpments. Newskah soils formed in material weathered from sandy marine sediment. Slope is 1 to 90 percent. Elevation is 50 to 500 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Newskah loam, 8 to 30 percent slopes, in Grays Harbor County, 3 miles northeast of Grayland, about 2,600 feet east and 2,200 feet north of the southwest corner of sec. 3, T. 15 N., R. 11 W.

O1-3 inches to 0; accumulation of moss, needles, and twigs.

A1-0 to 17 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; moderate very fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; many very fine tubular pores; strongly acid; clear smooth boundary.

B21-17 to 35 inches; dark yellowish brown (10YR 4/4) loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; common very fine tubular pores; very strongly acid; gradual smooth boundary.

B22-35 to 46 inches; dark yellowish brown (10YR 4/6) loam, light yellowish brown (10YR 6/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and medium roots; common very fine tubular pores; very strongly acid; clear smooth boundary.

C-46 to 60 inches; yellowish brown (10YR 5/6) loamy fine sand, yellow (10YR 7/6) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine tubular pores; very strongly acid.

The solum is 40 to 60 inches thick or more. The 10- to 40-inch control section is 15 to 20 percent clay.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 2 to 4 when dry. It is very strongly acid or strongly acid.

The B2 horizon has hue of 7.5YR or 10YR when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is dominantly loam, but in some places it is fine sandy loam below a depth of 40 inches. The horizon is extremely acid or very strongly acid.

The C horizon has hue of 10YR or 2.5Y when dry, value of 5 or 6 when moist and 6 or 7 when dry, and chroma of 4 to 6 when moist or dry. It is loamy sand or loamy fine sand and has thin gravelly strata in some places. The horizon is extremely acid or very strongly acid.

Nordby Series

The Nordby series consists of very deep, somewhat excessively drained soils on benches and terraces. Nordby soils formed in a mixture of valley and continental glacial outwash. Slope is 1 to 65 percent. Elevation is 300 to 900 feet. The average annual precipitation is 80 to 130 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are loamy-skeletal, mixed, mesic Typic Haplumbrepts.

Typical pedon of Nordby very gravelly loam, 1 to 8 percent slopes, in Grays Harbor County, 18 miles north of Montesano, about 1,800 feet west and 1,200 feet south of the northeast corner of sec. 21, T. 20 N., R. 7 W.

O1-3 inches to 0; partially decomposed leaf litter.

A1-0 to 13 inches; dark reddish brown (5YR 3/2) very gravelly loam, dark brown (7.5YR 4/2) dry; moderate fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine and medium roots and common very fine roots; many micro interstitial pores; 40 percent rounded pebbles; strongly acid; clear smooth boundary.

B21-13 to 24 inches; dark brown (7.5YR 3/4) extremely gravelly sandy loam, brown (7.5YR 5/4) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine, fine, and medium roots; many micro interstitial pores and common fine tubular pores; 60 percent rounded pebbles; strongly acid; clear smooth boundary.

B22-24 to 33 inches; dark brown (7.5YR 4/4) extremely gravelly sandy loam, brown (7.5YR 5/4) dry; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; 75 percent rounded pebbles; strongly acid; clear wavy boundary.

IIC1-33 to 50 inches; dark brown (7.5YR 3/4) extremely gravelly loamy sand, yellowish brown (10YR 5/6) dry; single grain; loose, nonsticky and nonplastic; few very fine roots; 90 percent rounded pebbles; strongly acid; clear smooth boundary.

IIC2-50 to 60 inches; dark yellowish brown (10YR 4/4) extremely gravelly sand, light yellowish brown (10YR 6/4) dry; single grain; weakly compacted; loose, nonsticky and nonplastic; 90 percent rounded pebbles and 2 percent rounded cobbles; very strongly acid.

The solum is 28 to 37 inches thick. It is very gravelly loam, very gravelly sandy loam, or extremely gravelly sandy loam and is 40 to 75 percent pebbles.

The A horizon has hue of 5YR when moist and 5YR or 7.5YR when dry, and it has chroma of 2 or 3 when moist or dry.

The B horizon has hue of 5YR or 7.5YR when moist and 7.5YR or 10YR when dry, value of 3 or 4 when moist and 5 or 6 when dry, and chroma of 3 or 4 when moist or dry. It is very gravelly loam, very gravelly sandy loam, or extremely gravelly sandy loam and is 40 to 75 percent pebbles.

The IIC horizon is extremely gravelly sand or extremely gravelly loamy sand and is 80 to 95 percent pebbles.

Norma Series

The Norma series consists of very deep, poorly drained soils on narrow flood plains. Norma soils formed in sandy alluvium. Slope is 0 to 2 percent. Elevation is 200 to 400 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are coarse-loamy, mixed, nonacid, mesic Mollic Haplaquepts.

Typical pedon of Norma sandy loam, in Grays Harbor County, 3 miles northwest of Elma, about 1,600 feet west and 600 feet north of the southeast corner of sec. 17, T. 18 N., R. 6 W.

O1-1 inch to 0; accumulation of leaves, twigs, and moss.

A1-0 to 10 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine, medium, and coarse roots; many very fine tubular pores; very strongly acid; abrupt wavy boundary.

B2g-10 to 29 inches; grayish brown (2.5Y 5/2) sandy loam, light brownish gray (2.5Y 6/2) dry; many medium prominent strong brown (7.5YR 5/8) mottles, reddish yellow (7.5YR 6/8) dry; weak thin platy structure; slightly hard, very friable, nonsticky and nonplastic; common fine and medium roots; many very fine interstitial pores; medium acid; gradual wavy boundary.

Cg-29 to 60 inches; dark gray (5YR 4/1) sandy loam, gray (5Y 6/1) dry; common fine and medium prominent strong brown (7.5YR 5/8) and dark reddish brown (5YR 3/4) mottles, reddish yellow (7.5YR 6/8) and reddish brown (5YR 4/4) dry; massive; slightly hard, very friable, nonsticky and nonplastic; few fine and medium roots; common very fine tubular pores; medium acid.

The control section averages less than 15 percent coarse fragments, less than 10 percent clay, and more than 15 percent fine sand and coarser textured material.

The A horizon has value of 2 or 3 when moist and 4 or 5 when dry, and it has chroma of 1 to 3 when moist or dry. It is very strongly acid to slightly acid.

The B horizon has hue of 10YR, 2.5Y, or 5Y when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 1 or 2 when moist or dry. It has prominent mottles that have high value and chroma. The horizon is medium acid or slightly acid. It is fine sandy loam, sandy loam, or silt loam.

Nuby Series

The Nuby series consists of very deep, poorly drained soils on flood plains. Drainage has been altered by ditching and tiling. Nuby soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 20 to 100 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 180 to 220 days. The average frost-free season is 150 to 200 days.

These soils are fine-silty, mixed, acid, mesic Typic Fluvaquents.

Typical pedon of Nuby silt loam, in Wahkiakum County, 4 miles northwest of Rosburg, about 1,050 feet south and 600 feet east of the northwest corner of sec. 9, T. 10 N., R. 8 W.

Ap-0 to 7 inches; grayish brown (10YR 5/2) silt loam, very pale brown (10YR 7/3) dry; common fine prominent yellowish red (5YR 5/8) mottles, moist or dry; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many medium, fine, and very fine roots; common medium and fine tubular pores; very strongly acid; abrupt smooth boundary.

C1-7 to 17 inches; light brownish gray (10YR 6/2) silt loam, light gray (10YR 7/2) dry; many medium prominent yellowish red (5YR 5/6) mottles, strong brown (7.5YR 5/8) dry; moderate medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common medium and fine roots; common medium and fine tubular pores; very strongly acid; gradual wavy boundary.

C2-17 to 60 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 7/2) dry; many medium distinct yellowish red (5YR 5/6) mottles, reddish yellow (7.5YR 6/6) dry; weak medium prismatic structure parting to weak medium and fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few medium and fine tubular pores; strongly acid.

Reaction is very strongly acid or strongly acid. The content of clay in the control section ranges from 18 to 35 percent.

The A horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 2 or 3 when moist.

The C horizon has value of 6 or 7 when dry, and it has chroma of 2 or 3 when moist or dry. It ranges from silt loam to silty clay loam.

O'Brien Series

The O'Brien series consists of very deep, well drained soils on terraces and uplands. O'Brien soils formed in glacial outwash. Slope is 1 to 15 percent. Elevation is 100 to 500 feet. The average annual precipitation is 90 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial over loamy-skeletal, mixed, mesic Andic Haplumbrepts.

Typical pedon of O'Brien silt loam, 1 to 15 percent slopes, in Grays Harbor County, 5 miles southwest of Humptulips, about 2,000 feet east and 2,400 feet south of the northwest corner of sec. 15, T. 20 N., R. 11 W.

O1-3 inches to 0.5 inch; accumulation of needles, twigs, and moss.

O2-0.5 inch to 0; decomposed organic matter.

A1-0 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, dark brown (10YR 3/3) dry; weak very fine and fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine, fine, and medium roots and few coarse roots; 6 percent hard subrounded and rounded pebbles and 1 percent hard subrounded and rounded cobbles; very strongly acid; clear wavy boundary.

B2-13 to 28 inches; brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak very fine and fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine and fine roots and few medium roots; 5 percent hard subrounded and rounded pebbles and 5 percent hard subrounded and rounded cobbles; very strongly acid; gradual wavy boundary.

B3-28 to 31 inches; dark yellowish brown (10YR 4/6) gravelly silt loam, light yellowish brown (10YR 6/4) dry; moderate very fine and fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; common very fine and few fine roots; 15 percent hard rounded pebbles and 5 percent hard rounded cobbles; very strongly acid; clear smooth boundary.

IIC1-31 to 35 inches; yellowish brown (10YR 5/4) very gravelly loam, light yellowish brown (10YR 6/4) dry; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; 40 percent hard rounded pebbles and 5 percent hard rounded cobbles; very strongly acid; abrupt smooth boundary.

IIC2-35 to 60 inches; brown (10YR 4/3) very gravelly sandy loam, light yellowish brown (10YR 6/4) dry; massive; soft, very friable, nonsticky and nonplastic; 50 percent hard rounded pebbles and 5 percent hard rounded cobbles; very strongly acid.

The solum is 20 to 40 inches thick. The upper part of the control section is 5 to 15 percent pebbles and 1 to 5 percent cobbles. The lower part of the control section is 35 to 50 percent pebbles and 5 to 10 percent cobbles. The profile is very strongly acid or strongly acid.

The A horizon has hue of 10YR or 7.5YR when moist, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 2 or 3 when moist and 3 or 4 when dry.

The B horizon has hue of 10YR or 7.5YR when moist, value of 5 or 6 when dry, and chroma of 3 to 6 when moist or dry.

Ocosta Series

The Ocosta series consists of very deep, poorly drained soils on flood plains and deltas. Drainage has been altered by ditching, tiling, and pumping. Ocosta soils formed in alluvium deposited in coastal bays. Slope is 0 to 2 percent. Elevation is sea level to 20 feet. The average annual precipitation is 70 to 100 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days. The average frost-free season is 150 to 200 days.

These soils are fine, mixed, acid, mesic Typic Fluvaquents.

Typical pedon of Ocosta silty clay loam, in Grays Harbor County, 1 mile west of South Aberdeen, about 2,600 feet west and 800 feet south of the northeast corner of sec. 20, T. 17 N., R. 9 W.

O1-3 inches to 0; partially decomposed remains of sedge and grass leaves interlaced with live fine roots.

A1-0 to 7 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; many coarse prominent yellowish red (5YR 4/8) mottles; moderate coarse angular blocky structure; hard, firm, sticky and very plastic; many medium and fine roots; many fine tubular and interstitial pores; extremely acid; abrupt smooth boundary.

C1g-7 to 12 inches; dark grayish brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; common medium prominent dark reddish brown (5YR 3/4) mottles; moderate coarse prismatic structure; very hard, firm, sticky and very plastic; many fine and medium roots; many medium tubular and interstitial pores; few moderately thick black (5YR 2/1) organic coatings along vertical surfaces of peds; extremely acid; clear smooth boundary.

C2g-12 to 20 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common medium distinct dark reddish brown (5YR 3/4) mottles; moderate coarse prismatic structure; very hard, very firm, sticky and very plastic; few fine roots; common medium tubular and interstitial pores; few moderately thick black (5YR 2/1) organic coatings on faces of peds; extremely acid; abrupt smooth boundary.

Oa-20 to 22 inches; black (5YR 2/1) sapric material, dark reddish brown (5YR 2/2) dry; massive; hard, friable; few fine roots; extremely acid; abrupt smooth boundary.

IIC3-22 to 60 inches; very dark grayish brown (2.5Y 3/2) clay, light brownish gray (2.5Y 6/2) dry; massive; very hard, very firm, very sticky and very plastic; strong sulphur smell; very strongly acid.

The solum is 14 to 26 inches thick and is very strongly acid or extremely acid. The control section is dominantly clay or silty clay. It averages 45 to 60 percent clay and less than 15 percent rock fragments.

The A1 horizon has hue of 10YR to 5Y when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 1 or 2 when moist or dry.

The Cg horizon has hue of 2.5Y or 5Y when moist or dry, and it has value of 5 or 6 when dry. It is dominantly silty clay or clay, but the range includes silty clay loam.

The IIC horizon has hue of 2.5Y or 5Y when moist or dry and value of 3 or 4 when moist and 4 to 6 when dry. It has thin strata of silt loam.

The Oa horizon may be at any depth less than 60 inches. The thickness of the Oa horizon is less than 12 inches.

Olympic Series

The Olympic series consists of very deep, well drained soils on uplands. Olympic soils formed in material weathered from basalt. Slope is 1 to 65 percent. Elevation is 250 to 1,800 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season is 200 to 240 days.

These soils are clayey, mixed, mesic Xeric Haplohumults.

Typical pedon of Olympic clay loam, 8 to 30 percent slopes, in Grays Harbor County, 4 miles northeast of Porter, about 2,400 feet south and 1,400 feet west of the northeast corner of sec. 2, T. 17 N., R. 5 W.

O1-2 inches to 0; accumulation of Douglas-fir needles and twigs.

A1-0 to 7 inches; dark brown (7.5YR 3/2) clay loam, brown (7.5YR 5/4) dry; strong fine and medium granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine, medium, and coarse roots; many very fine interstitial pores; slightly acid; clear smooth boundary.

A3-7 to 14 inches; dark brown (7.5YR 3/2) silty clay loam, brown (7.5YR 5/4) dry; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and plastic; common fine and medium roots and few coarse roots; many very fine tubular pores; medium acid; gradual smooth boundary.

B21t-14 to 22 inches; dark brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 5/6) dry; weak fine and medium subangular blocky structure; hard, friable, slightly sticky and plastic; common fine roots; common very fine tubular pores; few thin clay films on faces of peds and in pores; medium acid; gradual smooth boundary.
B22t-22 to 35 inches; dark brown (7.5YR 4/4) silty clay, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; common very fine tubular pores; few thin clay films on faces of peds and in pores; strongly acid; gradual smooth boundary.
B23t-35 to 60 inches; yellowish red (5YR 4/6) silty clay, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; common very fine tubular pores; common thin clay films on faces of peds and in pores; very strongly acid.

The solum is 60 inches to more than 100 inches thick. Hue throughout the solum is 7.5YR or 5YR when moist or dry. Reaction ranges from slightly acid to very strongly acid. The control section is 35 to 60 percent clay and is clay loam, silty clay loam, silty clay, or clay.

The A horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 2 or 3 when moist and 2 to 4 when dry.

The B horizon has value of 3 or 4 when moist and 4 to 6 when dry, and it has chroma of 4 to 8 when moist or dry. It is clay loam, silty clay loam, silty clay, or clay and is 0 to 75 percent rock fragments below a depth of 40 inches.

Orcas Series

The Orcas series consists of very deep, very poorly drained organic soils in depressional areas or basinlike areas in or between sand dunes. Drainage has been altered by ditching. Orcas soils formed in sphagnum and hypnum moss. Slope is 0 to 1 percent. Elevation is 10 to 30 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 160 to 180 days.

These soils are dysic, mesic Typic Sphagnofibrists.

Typical pedon of Orcas peat, in Pacific County, 8 miles southeast of Grayland, about 1,925 feet west and 150 feet south of the northeast corner of sec. 29, T. 15 N., R. 11 W.

O1-4 inches to 0; live sphagnum moss.
Oi1-0 to 8 inches; dark reddish brown (5YR 3/2) fibric material; about 95 percent fiber, 90 percent rubbed; 10 percent hemic material; weak thick platy structure; loose, very friable, nonsticky and nonplastic; many medium, fine, and very fine roots; extremely acid; abrupt smooth boundary.
Oi2-8 to 60 inches; dark reddish brown (5YR 3/3) fibric material; about 95 percent fiber, 90 percent rubbed; less than 10 percent hemic material; massive; friable, nonsticky and nonplastic; extremely acid.

Depth to mineral soil material ranges from 48 inches to more than 60 inches. Few wood fragments are at any depth.

The Oi1 horizon is peat or mucky peat. It has hue of 5YR or 7.5YR when moist, value of 2 or 3 when moist, and chroma of 2 or 3 when moist.

The Oi2 horizon has hue of 5YR or 7.5YR when moist, value of 3 or 4 when moist, and chroma of 3 or 4 when moist. It is 5 to 10 percent hemic material and 90 to 95 percent fibric material.

Oyhut Series

The Oyhut series consists of moderately deep, moderately well drained soils on terraces. Oyhut soils formed in material weathered from glacial outwash. Slope is 1 to 15 percent. Elevation is 50 to 300 feet. The average annual precipitation is 90 to 120 inches, the average annual air temperature is 46 to 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Oyhut silt loam, 1 to 15 percent slopes, in Grays Harbor County, 6 miles west of Humptulips, about 1,200 feet north and 200 feet east of the southwest corner of sec. 9, T. 20 N., R. 11 W.

O1-7 inches to 0; partially decomposed wood, twigs, and needles.
A1-0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; weakly smeary; many very fine, fine, medium, and coarse roots; many very fine and fine tubular pores; 3 percent hard rounded pebbles; very strongly acid; gradual wavy boundary.
B2-9 to 24 inches; dark brown (10YR 3/3) silt loam, yellowish brown (10YR 5/4) dry; weak very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; many very fine and fine tubular pores; 3 percent hard' rounded pebbles; very strongly acid; clear smooth boundary.
B3-24 to 29 inches; yellowish brown (10YR 5/6) gravelly silt loam, yellow (10YR 7/6) dry; common fine faint strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; few medium tubular pores and common fine and very fine tubular

pores; 30 percent hard rounded pebbles; very strongly acid; abrupt smooth boundary.
IICirm-29 inches; strong brown (7.5YR 5/6) iron-cemented dense glacial outwash, reddish yellow (7.5YR 6/6) dry; massive; very hard, very firm, nonsticky and nonplastic; 70 percent hard rounded pebbles; very strongly acid.

The solum is 24 to 40 inches thick. The control section averages 10 to 35 percent hard rounded pebbles and cobbles; pebbles are dominant.

The B2 horizon is 0 to 15 percent rock fragments, and the 83 horizon is 25 to 50 percent rock fragments.

The IICirm horizon is 60 to 80 percent pebbles and cobbles.

Palix Series

The Palix series consists of deep, well drained soils on uplands. Palix soils formed in material weathered from siltstone or very fine sandstone. Slope is 8 to 90 percent. Elevation is sea level to 1,100 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is 46 to 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Palix silt loam, 8 to 30 percent slopes, in Pacific County, 6 miles northwest of Raymond, about 2,225 feet west and 1,700 feet north of the southeast corner of sec. 23, T. 15 N., R. 9 W.

O1-1 inch to 0; accumulation of needles and twigs.
A1-0 to 18 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine and very fine roots and few medium and coarse roots; many very fine tubular pores; 20 percent pebble-sized fragments of soft siltstone; very strongly acid; clear wavy boundary.
B21-18 to 25 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; weakly smeary; common fine and very fine roots; common very fine tubular pores; 30 percent pebble-sized fragments of soft siltstone; very strongly acid; clear wavy boundary.
B22-25 to 30 inches; strong brown (7.5YR 5/6) silty clay loam, reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure; hard, firm, sticky and plastic; weakly smeary; few fine and very fine roots; common very fine tubular pores; 35 percent pebble-sized fragments of soft siltstone; extremely acid; clear wavy boundary.
B3-30 to 46 inches; yellowish brown (10YR 5/4) silty clay loam, light yellowish brown (10YR 6/4) dry; weak fine angular blocky structure; hard, firm, sticky and plastic; weakly smeary; few very fine roots; few very fine tubular pores; 50 percent pebble-sized fragments of soft siltstone; very strongly acid; clear smooth boundary.
Cr-46 inches; partly consolidated siltstone; cracks are 2 to 5 inches apart.

Thickness of the solum and depth to paralithic contact are 40 inches to more than 60 inches. The 10- to 40inch control section is 27 to 35 percent clay. Reaction is very strongly acid or extremely acid. The umbric epipedon is 12 to 20 inches thick.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B horizon has hue of 7.5YR or 10YR when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is silty clay loam or clay loam and is 20 to 80 percent fragments of soft siltstone.

Papac Series

The Papac series consists of moderately deep, well drained soils on glacial terraces and terrace escarpments. Papac soils formed in material weathered from glacial drift. Slope is 1 to 65 percent. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is about 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Papac gravelly silt loam, 8 to 30 percent slopes, in Grays Harbor County, 2 miles east of Moclips, about 200 feet east and 600 feet north of the southwest corner of sec. 10, T. 20 N., R. 12 W.

O1-3 inches to 0; western hemlock needles, twigs, and moss.
A1-0 to 4 inches; very dark brown (10YR 2/2) gravelly silt loam, very dark grayish brown (10YR 3/2) dry; strong fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many very fine roots, common fine and medium roots, and few coarse roots; many very fine tubular and interstitial pores; 15 percent rounded pebbles; extremely acid; abrupt smooth boundary.
A3-4 to 12 inches; very dark grayish brown (10YR 3/2) gravelly silt loam, dark brown (7.5YR 4/2) dry; strong fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine, fine, medium, and coarse roots; common very fine tubular and interstitial pores; 20 percent rounded pebbles; very strongly acid; clear smooth boundary.
B21-12 to 16 inches; dark yellowish brown (10YR 4/4) gravelly silt loam, yellowish brown (10YR 5/6) dry;

moderate very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common very fine and medium roots and few fine and coarse roots; many very fine tubular and interstitial pores; 20 percent rounded pebbles; very strongly acid; clear wavy boundary.

B22-16 to 24 inches; dark brown (7.5YR 4/4) gravelly silty clay loam, yellowish brown (10YR 5/6) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few coarse roots and common very fine, fine, and medium roots; many very fine tubular and interstitial pores; 25 percent rounded pebbles; strongly acid; clear smooth boundary.

B23-24 to 33 inches; yellowish brown (10YR 5/4) gravelly silty clay loam, light yellowish brown (10YR 6/4) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and plastic; weakly smeary; common very fine and fine roots; common very fine tubular and interstitial pores; 25 percent rounded pebbles; strongly acid; abrupt smooth boundary.

IICr-33 inches; light olive brown (2.5Y 5/4) dense glacial till that crushes to very gravelly sandy loam, light yellowish brown (2.5Y 6/4) dry; massive; weakly cemented; hard, firm, nonsticky and nonplastic; 50 percent rounded pebbles; medium acid.

Thickness of the solum and depth to dense glacial till are 20 to 40 inches. The umbric epipedon is 10 to 17 inches thick.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 2 or 3 when moist or dry. It is 15 to 25 percent coarse fragments. The horizon is very strongly acid or extremely acid.

The B2 horizon has hue of 7.5YR or 10YR when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is gravelly silt loam or gravelly silty clay loam and is 15 to 35 percent coarse fragments. The horizon is strongly acid or very strongly acid.

The IICr horizon has hue of 10YR or 2.5Y when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is dense glacial drift that crushes to very gravelly sandy loam, extremely gravelly sandy loam, very gravelly loam, or extremely gravelly loam. The content of coarse fragments ranges from 40 to 70 percent.

Raught Series

The Raught series consists of very deep, well drained soils on uplands. Raught soils formed in material weathered from basalt. Slope is 5 to 90 percent. Elevation is 100 to 1,500 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andic Typic Xerumbrepts.

Typical pedon of Raught silt loam, 30 to 65 percent slopes, in Wahkiakum County, 9 miles east of Cathlamet, about 400 feet west and 1,500 feet south of the northeast corner of sec. 18, T. 8 N., R. 4 W.

O1-1 inch to 0; partially decomposed leaf litter.

A11-0 to 2 inches; dark reddish brown (5YR 3/2) silt loam, dark reddish gray (5YR 4/2) dry; strong fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; many medium and fine roots; many medium and fine tubular pores; medium acid; clear wavy boundary.

A12-2 to 7 inches; dark reddish brown (5YR 3/3) silt loam, reddish brown (5YR 5/3) dry; moderate medium and fine granular structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; common medium and fine roots; many medium and fine tubular pores; strongly acid; gradual wavy boundary.

B21-7 to 17 inches; dark reddish brown (5YR 3/3) silt loam, reddish brown (5YR 5/3) dry; moderate coarse, medium, and fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; common medium and fine roots; common medium and fine tubular pores; 5 percent pebbles; strongly acid; clear smooth boundary.

B22-17 to 31 inches; dark reddish brown (5YR 3/4) silt loam, reddish brown (5YR 5/4) dry; weak coarse and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; few coarse and medium roots; common medium and fine tubular pores; 5 percent pebbles; strongly acid; clear smooth boundary.

B23-31 to 60 inches; dark red (2.5YR 3/6) silt loam, reddish brown (5YR 5/4) dry; weak very coarse and coarse subangular blocky structure parting to coarse and medium subangular blocky; hard, friable, slightly sticky and slightly plastic; weakly smeary; few coarse roots; few very fine tubular pores; 10 percent pebbles; strongly acid.

The A horizon has hue of 5YR or 7.5YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist.

The B horizon has hue of 2.5YR to 7.5YR when moist or dry, value of 3 to 5 when moist or dry, and chroma of 3 to 6 when moist and 3 to 5 when dry. It is silt loam or silty clay loam and is 0 to 15 percent pebbles and 0 to 20 percent cobbles.

Rennie Series

The Rennie series consists of very deep, poorly drained soils on flood plains. Rennie soils formed in alluvium. Slope is 0 to 2 percent. Elevation is sea level to 100 feet. The average annual precipitation is 70 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 180 to 200 days.

These soils are fine, montmorillonitic, nonacid, mesic Mollic Fluvaquents.

Typical pedon of Rennie silty clay loam, in Grays Harbor County, 1.5 miles south of Brady, about 1,900 feet east and 950 feet south of the northwest corner of sec. 11, T. 17 N., R. 7 W.

A1g-0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; common fine faint yellowish red (5YR 5/8) and light brownish gray (2.5Y 6/2) mottles; moderate fine angular blocky structure; very hard, friable, sticky and plastic; many coarse, medium, and fine roots; many medium and fine tubular pores; about 10 percent organic matter; strongly acid; abrupt smooth boundary.

B21g-7 to 13 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (2.5Y 6/2) dry; common medium prominent dark reddish brown (2.5YR 3/4) mottles; moderate medium angular blocky structure; very hard, friable, sticky and plastic; many medium and fine roots; many medium and fine tubular pores; strongly acid; clear smooth boundary.

B22g-13 to 38 inches; grayish brown (2.5Y 5/2) silty clay, gray (5Y 6/1) dry; common medium prominent yellowish red (5YR 5/8) mottles; strong fine angular blocky structure; extremely hard, firm, very sticky and very plastic; few fine roots; many fine tubular and interstitial pores; medium acid; gradual wavy boundary.

B23g-38 to 54 inches; grayish brown (2.5Y 5/2) clay, gray (5Y 6/1) dry; common medium prominent yellowish red (5YR 5/8) mottles; moderate fine angular blocky structure; extremely hard, firm, very sticky and very plastic; few fine roots; many fine tubular and interstitial pores; medium acid; abrupt smooth boundary.

Cg-54 to 60 inches; dark greenish gray (5GY 4/1) clay, greenish gray (5GY 5/1) dry; massive; extremely hard, firm, very sticky and very plastic; medium acid.

The solum is 40 to 60 inches thick or more. Unless the profile is artificially drained, it is saturated with water most of the year. The profile is medium acid or strongly acid throughout. The control section is dominantly silty clay or clay, but the range includes silty clay loam in the upper part. The control section averages 45 to 60 percent clay and is less than 10 percent coarse fragments.

The A horizon has hue of 10YR or 2.5Y when moist or dry, value of 5 or 6 when dry, and chroma of 2 or 3 when moist or dry.

The B2 horizon has hue of 10YR to 5YR when moist or dry, value of 4 or 5 when moist and 6 or 7 when dry, and chroma of 1 or 2 when moist or dry. It is dominantly silty clay or clay, but the range includes silty clay loam in the upper part.

The C horizon has hue of 5GY to 2.5Y or N when moist or dry, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of less than 2 when moist or dry.

Salzer Series

The Salzer series consists of very deep, very poorly drained soils on flood plains. Salzer soils formed in alluvium. Slope is 0 to 2 percent. Elevation is 25 to 200 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is about 51 degrees F, and the average growing season is 150 to 200 days.

These soils are fine, montmorillonitic, acid, mesic Vertic Haplaquepts.

Typical pedon of Salzer silty clay, in Grays Harbor County, 1 mile southwest of Oakville, about 1,700 feet west and 2,000 feet north of the southeast corner of sec. 32, T. 16 N., R. 4 W.

Ap-0 to 6 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (10YR 5/2) dry; common fine distinct strong brown (7.5YR 5/8) mottles; moderate fine angular blocky structure; very hard, friable, sticky and plastic; many fine grass roots; many medium interstitial pores and many fine tubular pores; vertical cracks 0.25-inch in width; very strongly acid; abrupt smooth boundary.

B21g-6 to 12 inches; dark gray (5Y 4/1) clay, gray (5Y 6/1) dry; common fine distinct yellowish red (5YR 5/8) mottles; weak medium prismatic structure parting to strong medium angular blocky; extremely hard, firm, sticky and very plastic; common fine grass roots; many medium tubular pores; vertical cracks 0.25-inch in width; few organic coatings on vertical sides of peds; very strongly acid; clear smooth boundary.

B22g-12 to 21 inches; dark gray (5Y 4/1) clay, light olive gray (5Y 6/2) dry; common medium distinct yellowish red (5YR 5/8) mottles; weak medium prismatic structure parting to strong medium angular blocky; extremely hard, firm, sticky and very plastic; common fine roots; common medium and fine tubular pores; vertical cracks; very strongly acid; clear smooth boundary.'

B23g-21 to 29 inches; olive gray (5Y 5/2) clay, light olive gray (5Y 6/2) dry; many medium distinct yellowish red (5YR 4/8) mottles; weak medium

prismatic structure parting to strong medium angular blocky; extremely hard, firm, sticky and very plastic; few fine roots; common medium and fine tubular pores; vertical cracks; few thin clay films in pores; extremely acid; gradual smooth boundary.

B24g-29 to 50 inches; gray (5Y 5/1) clay, light gray (5Y 7/2) dry; common medium prominent yellowish red (5YR 4/8) mottles; moderate coarse prismatic structure parting to strong medium angular blocky; extremely hard, firm, sticky and very plastic; few fine flattened grass roots; few medium interstitial pores and common medium tubular pores; vertical cracks; few thin organic coatings on vertical sides of peds; few thin clay films in pores; very strongly acid; gradual wavy boundary.

IIC1-50 to 59 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (5Y 7/2) dry; many medium distinct yellowish red (5YR 4/8) mottles; massive; extremely hard, friable, sticky and plastic; few fine roots; few fine tubular and interstitial pores; medium acid; abrupt wavy boundary.

IIC2-59 to 60 inches; dark grayish brown (2.5Y 4/2) sandy clay loam, light olive gray (5Y 6/2) dry; common medium distinct dark red (2.5YR 3/6) mottles; massive; hard, friable, slightly sticky and plastic; few fine roots; few fine interstitial pores; common fine black concretions that are soft and smeary; medium acid.

The profile is extremely acid to medium acid throughout. When dry for short durations, it commonly has cracks 0.5-inch in width extending from the surface to a depth of 24 inches.

The A horizon has hue of 10YR to 5Y when moist or dry, value of 2 to 4 when moist and 5 to 7 when dry, and chroma of 1 or 2 when moist or dry. It is faintly to prominently mottled.

The B horizon has hue of 2.5Y or 5Y when moist or dry, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of less than 2 when moist or dry.

The C horizon has the same color range as the B horizon. It is sandy clay loam, clay loam, or silty clay loam.

Satsop Series

The Satsop series consists of very deep, well drained soils on alluvial fans and stream terraces. Satsop soils formed in alluvium. Slope is 1 to 8 percent. Elevation is 30 to 300 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are coarse-loamy, mixed, mesic Typic Dystrochrepts.

Typical pedon of Satsop silt loam, 1 to 8 percent slopes, in Grays Harbor County, 0.25 mile north of Satsop, about 1,300 feet west and 1,600 feet north of the southeast corner of sec. 30, T. 18 N., R. 6 W.

Ap-0 to 7 inches; very dark brown (10YR 2/2) silt loam, brown (10YR 5/3) dry; moderate fine granular structure; soft, friable, nonsticky and slightly plastic; many fine roots; many medium, fine, and very fine tubular pores; very strongly acid; clear smooth boundary.

B2-7 to 28 inches; olive brown (2.5Y 4/4) silt loam, light yellowish brown (2.5Y 6/4) dry; weak very fine subangular blocky structure; soft, friable, nonsticky and slightly plastic; common fine roots; many medium, fine, and very fine tubular pores; medium acid; abrupt smooth boundary.

C-28 to 60 inches; light olive brown (2.5Y 5/4) very fine sandy loam, pale olive (5Y 6/3) dry; massive; loose, very friable, nonsticky and nonplastic; few fine roots; many medium, fine, and very fine tubular pores; medium acid.

The A horizon has hue of 10YR or 7.5YR when moist or dry, value of 2 or 3 when moist, and chroma of 2 or 3 when moist or dry. It is very strongly acid or strongly acid.

The B2 horizon has hue of 10YR or 2.5Y when moist or dry, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist or dry. It is silt loam, loam, or sandy loam and is strongly acid or medium acid.

The C horizon has hue of 10YR, 2.5Y, or 5Y when moist or dry, value of 3 to 5 when moist and 6 or 7 when dry, and chroma of 3 or 4 when moist or dry. It is very fine sandy loam or sandy loam. In some places loamy sand or sand is below a depth of 40 inches. The C horizon is strongly acid or medium acid.

Sauvie Series

The Sauvie series consists of very deep, poorly drained soils on flood plains protected from tidal overflow. Drainage has been altered by ditching, tiling, and pumping. Sauvie soils formed in alluvium. Slope is 0 to 2 percent. Elevation is 10 to 20 feet. The average annual precipitation is 50 to 60 inches, the average annual air temperature is about 53 degrees F, and the average frost-free season is 165 to 200 days.

These soils are fine-silty, mixed, mesic Fluvaquentic Haplaquolls.

Typical pedon of Sauvie silt loam, in Wahkiakum County, 3 miles southwest of Cathlamet, about 1,000 feet east and 1,800 feet north of the southwest corner of sec. 10, T. 8 N., R. 6 W.

Ap-0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; common fine prominent strong brown (7.5YR 5/6) mottles, strong brown (7.5YR 5/8) dry; moderate coarse subangular

blocky structure parting to strong medium subangular blocky; slightly hard, friable, nonsticky and nonplastic; many fine roots; few micro interstitial pores; medium acid; clear smooth boundary.

B21g-10 to 14 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; common medium prominent strong brown (7.5YR 5/6) mottles, reddish yellow (7.5YR 6/8) dry; moderate medium prismatic structure parting to strong coarse subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine roots; common fine tubular pores and common very fine interstitial pores; slightly acid; clear wavy boundary.

B22g-14 to 19 inches; dark grayish brown (10YR 4/2) silty clay loam, light brownish gray (10YR 6/2) dry; common medium prominent yellowish red (5YR 4/8) mottles, reddish yellow (5YR 6/8) dry; moderate coarse subangular blocky structure parting to moderate medium and fine subangular blocky; hard, firm, slightly sticky and slightly plastic; common fine roots; few fine tubular pores and few very fine interstitial pores; neutral; clear wavy boundary.

B23g-19 to 26 inches; dark gray (10YR 4/1) silty clay loam, light brownish gray (10YR 6/2) dry; many medium prominent strong brown (7.5YR 5/8) mottles, reddish yellow (7.5YR 6/8) dry; moderate coarse subangular blocky structure parting to medium and fine subangular blocky; hard, friable, nonsticky and nonplastic; common fine roots; few fine tubular pores and few very fine interstitial pores; slightly acid; clear wavy boundary.

Cg-26 to 60 inches; dark gray (N 4/0) silt loam, light brownish gray (10YR 6/2) dry; many medium prominent strong brown (7.5YR 5/8) mottles, reddish yellow (7.5YR 6/8) dry; massive; hard, friable, nonsticky and nonplastic; slightly acid.

Unless the soils are artificially drained, they are saturated with water throughout the year. Unless the soils are diked, they are subject to flooding by freshwater during high tide. The 10- to 40-inch control section is 25 to 37 percent clay.

The A horizon has chroma of 1 or 2 when moist.

The B2g horizon has value of 3 or 4 when moist, and it has chroma of 1 or 2 when moist or dry.

The Cg horizon has value of 4 or 5 when moist and 6 or 7 when dry. It has strata of sandy loam to loam in some places.

Schneider Series

The Schneider series consists of very deep, well drained soils on uplands. Schneider soils formed in material weathered from basalt. Slope is 8 to 65 percent. Elevation is 600 to 1,200 feet. The average annual precipitation is 60 to 70 inches, the average annual air temperature is about 49 degrees F, and the average growing season is 200 to 240 days.

These soils are medial-skeletal, mesic Andic Xerumbrepts.

Typical pedon of Schneider very gravelly silt loam, very deep, 8 to 30 percent slopes, in Grays Harbor County, 2 miles east of McCleary, about 1,000 feet south and 600 feet west of the northeast corner of sec. 18, T. 18 N., R. 4 W.

O1-1 inch to 0; accumulation of Douglas-fir needles, twigs, and moss.

A11-0 to 3 inches; dark brown (7.5YR 3/2) very gravelly silt loam, dark brown (7.5YR 4/2) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; many fine, medium, and coarse roots; many very fine interstitial pores; 50 percent angular basalt pebbles; 10 percent medium hard iron-manganese concretions; slightly acid; clear smooth boundary.

A12-3 to 10 inches; dark reddish brown (5YR 3/3) very gravelly silt loam, dark brown (7.5YR 4/4) dry; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; many medium and coarse roots and common fine roots; many very fine interstitial pores; 55 percent angular basalt pebbles; medium acid; clear smooth boundary.

A3-10 to 27 inches; dark reddish brown (5YR 3/3) very gravelly silt loam, dark brown (7.5YR 4/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine, medium, and coarse roots; common very fine tubular pores; 55 percent angular basalt pebbles; medium acid; gradual wavy boundary.

B2-27 to 51 inches; dark brown (7.5YR 4/4) extremely gravelly silt loam, yellowish brown (10YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; common fine, medium, and coarse roots; common very fine tubular pores; 70 percent angular basalt pebbles; medium acid; gradual wavy boundary.

C-51 to 60 inches; dark yellowish brown (10YR 3/4) extremely gravelly silt loam, yellowish brown (10YR 5/4) dry; massive; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine roots; 85 percent angular basalt pebbles; medium acid.

The 10- to 40-inch control section averages 35 to 80 percent rock fragments, dominantly pebbles. The control section averages 18 to 25 percent clay. The profile is slightly acid or medium acid throughout.

The Al horizon has hue of 5YR or 7.5YR when moist, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 2 or 3 when moist.

The A3 horizon has hue of 5YR or 7.5YR when moist or dry, value of 2 or 3 when moist and 3 to 5 when dry,

and chroma of 3 or 4 when dry. It is very gravelly loam or very gravelly silt loam.

The B2 horizon has hue of 5YR to 10YR when moist or dry, value of 3 to 5 when moist and 4 to 7 when dry, and chroma of 3 or 4 when moist or dry.

Seastrand Series

The Seastrand series consists of very deep, very poorly drained organic soils in depressional areas or basinlike areas between sand dunes. Drainage has been altered by ditching. Seastrand soils formed in highly decomposed herbaceous material that is underlain by sand. Slope is 0 to 1 percent. Elevation is 10 to 30 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 160 to 180 days.

These soils are sandy or sandy-skeletal, mixed, dysic, mesic Terric Medihemists.

Typical pedon of Seastrand mucky peat, in Grays Harbor County, 0.25 mile northeast of Grayland, about 1,100 feet north and 1,700 feet west of the southeast corner of sec. 6, T. 15 N., R. 11 W.

Oe1-0 to 6 inches; black (10YR 2/1-broken faces, rubbed and pressed) hemic material; about 35 percent fiber, 20 percent rubbed; weak fine granular structure; very friable, slightly sticky and slightly plastic; many fine and medium roots and common coarse roots; extremely acid; clear smooth boundary.

Oe2-6 to 15 inches; very dark brown (10YR 2/2-broken faces), black (10YR 2/1-rubbed and pressed) hemic material; about 50 percent fiber, 20 percent rubbed; laminar structure; very friable, slightly sticky and slightly plastic; common fine and medium roots and few coarse roots; extremely acid; gradual smooth boundary.

Oe3-15 to 30 inches; dark reddish brown (5YR 3/2-broken faces), dark reddish brown (5YR 2/2-rubbed and pressed) hemic material; about 60 percent fiber, 30 percent rubbed; weak coarse subangular blocky structure; very friable, nonsticky and nonplastic; few fine roots and common medium and coarse roots; very strongly acid; abrupt smooth boundary.

IICg-30 to 60 inches; dark grayish brown (10YR 4/2) sand, gray (5Y 5/1) dry; single grain; loose, very friable, nonsticky and nonplastic; few fine roots; very strongly acid.

Depth to the IIC horizon ranges from 16 to 50 inches. The profile is extremely acid or very strongly acid throughout. The fiber is generally from sedges and grasses.

The organic material has hue of 10YR, 7.5YR, or 5YR when moist, value of 2 or 3 when moist, and chroma of 1 to 4 when moist. It is 35 to 70 percent fiber when not rubbed and is 17 to 35 percent fiber when rubbed.

The IIC horizon has hue of 10YR or 5Y when moist, value of 4 when moist, and chroma of 1 or 2 when moist.

Seastrand Variant

The Seastrand Variant consists of very deep, very poorly drained organic soils in depressional areas or basinlike areas between sand dunes. Drainage has been altered by ditching. Seastrand Variant soils formed in decomposed herbaeous plant material. Slope is 0 to 1 percent. Elevation is sea level to 30 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is about 48 degrees F, and the average frost-free season is 160 to 180 days.

These soils are dysic, mesic Typic Medihemists.

Typical pedon of Seastrand Variant muck, in Pacific County, 1 mile east of Holman, about 2,425 feet west and 2,200 feet north of the southwest corner of sec. 28, T. 10 N., R. 11 W.

O1-3 inches to 0; needles, twigs, leaves, bark, and fine roots.

Oa1-0 to 18 inches; dark reddish brown (5YR 2/2-rubbed and pressed) sapric material; about 45 percent fiber, 15 percent rubbed; weak fine and medium granular structure; friable, nonsticky and nonplastic; many coarse, medium, and fine live roots; extremely acid; abrupt smooth boundary.

Oe1-18 to 60 inches; dark reddish brown (5YR 3/2-rubbed and pressed) hemic material; about 60 percent fiber, 35 percent rubbed; massive; very friable, nonsticky and nonplastic; few fine live roots to a depth of 36 inches; extremely acid.

Sandy material is at a depth of 52 inches to more than 120 inches. The fiber is mostly from sedges. The content of wood fragments is as much as 40 percent in some places.

The Oa1 horizon has hue of 5YR or 7.5YR when moist, value of 2 or 3 when moist, and chroma of 2 or 3 when moist. It is 35 to 65 percent fiber when not rubbed and is 15 to 20 percent fiber when rubbed.

The Oa2 horizon has hue of 5YR or 7.5YR when moist, value of 2 or 3 when moist, and chroma of 2 to 4 when moist. It is 45 to 65 percent fiber when not rubbed and is 30 to 45 percent fiber when rubbed.

Skamo Series

The Skamo series consists of very deep, moderately well drained soils on terraces and fans. Skamo soils formed in alluvium. Slope is 0 to 8 percent. Elevation is 50 to 200 feet. The average annual precipitation is 50 to 90 inches, the average annual air temperature is about

50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Skamo silt loam, 0 to 8 percent slopes, in Grays Harbor County, 1 mile northwest of Cedarville, about 1,800 feet north and 300 feet east of the southwest corner of sec. 15, T. 16 N., R. 5 W.

O1-1.5 inches to 0.25 inch; needles, leaves, twigs, moss, and mycelium.
O2-0.25 inch to 0; black (10YR 2/1) decomposed remains of needles, leaves, twigs, and moss.
A11-0 to 3 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine and medium roots; common medium vesicular and interstitial pores; slightly acid; clear smooth boundary.
A12-3 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; many fine and medium roots; many fine and medium interstitial pores; slightly acid; clear smooth boundary.
A3-10 to 19 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; weakly smeary; common fine and medium roots; common fine and medium interstitial pores; medium acid; clear smooth boundary.
B21-19 to 29 inches; dark yellowish brown (10YR 3/4) silty clay loam, brown (10YR 5/3) dry; common fine very dark grayish brown (10YR 3/2) stains on surfaces of peds; moderate fine subangular and angular blocky structure; very hard, friable, sticky and plastic; few fine roots; common medium and fine tubular and interstitial pores; thin discontinuous clay films on faces of peds; very strongly acid; clear wavy boundary.
B22-29 to 48 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; many medium distinct grayish brown (2.5Y 5/2) mottles, few fine pale brown (10YR 6/3) mottles when dry; moderate very fine subangular and angular blocky structure; very hard, friable, sticky and plastic; few fine roots; common fine and medium tubular pores; thin discontinuous clay films on faces of peds; very strongly acid; clear wavy boundary.
C1-48 to 60 inches; dark brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; common medium distinct dark reddish brown (2.5YR 3/4) and light olive brown (2.5Y 5/4) mottles, strong brown (7.5YR 5/8) dry; massive; very hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; common fine and medium vertical tubular pores; strongly acid.

The solum is more than 40 inches thick. The control section averages 35 to 45 percent apparent clay and is 0 to 10 percent rock fragments. Depth to mottles that have chroma of 2 or less ranges from 24 to 40 inches. The umbric epipedon is 10 to 20 inches thick.

The A1 horizon has hue of 10YR or 7.5YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The A3 horizon has the same color range as the Al horizon. The A3 horizon is silt loam or silty clay loam and is medium acid or strongly acid.

The B2 horizon has hue of 7.5YR to 2.5Y when moist or dry, value of 3 or 4 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist or dry. It is silty clay loam or silty clay and is strongly acid or very strongly acid.

The C horizon has hue of 10YR or 2.5Y when moist or dry, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 3 or 4 when moist or dry. The C horizon is silt loam, silty clay loam, or silty clay. It is strongly acid or very strongly acid.

Spanaway Series

The Spanaway series consists of very deep somewhat excessively drained soils on outwash terraces. Spanaway soils formed in glacial outwash. Slope is 1 to 8 percent. Elevation is 100 to 200 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 51 degrees F, and the average growing season is 200 to 240 days.

These soils are sandy-skeletal, mixed, mesic Andic Xerumbrepts.

Typical pedon of Spanaway very gravelly sandy loam, 1 to 8 percent slopes, in Grays Harbor County, 0.5 mile south of Cedarville, about 1,000 feet west and 1,700 feet south of the northeast corner of sec. 22, T. 16 N., R. 5 W.

O2-1 inch to 0; black (10YR 2/1) decomposed moss.
A1-0 to 11 inches; black (10YR 2/1) very gravelly sandy loam, very dark grayish brown (10YR 3/2) dry; moderate fine and medium granular structure; soft, very friable, nonsticky and nonplastic; many fine roots; 55 percent pebbles and 4 percent cobbles; strongly acid; clear wavy boundary.
B2-11 to 16 inches; dark yellowish brown (10YR 4/6) extremely gravelly sandy loam, yellowish brown (10YR 5/4) dry; weak fine and very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine roots; 75 percent pebbles and 6 percent cobbles; strongly acid; clear wavy boundary.
IIC-16 to 60 inches; dark grayish brown (2.5Y 4/2) extremely gravelly sand, light brownish gray (2.5Y

6/2) dry; single grain; loose; few fine roots to a depth of 30 inches; 75 percent pebbles and 10 percent cobbles; slightly acid.

The solum is 14 to 22 inches thick. The content of coarse fragments in the control section averages 50 to 85 percent. The weighed average texture of the control section is extremely gravelly sand. The umbric epipedon is 10 to 20 inches thick.

The A1 horizon has hue of 5YR to 10YR when moist or dry, value of 3 or 4 when dry, and chroma of 1 or 2 when moist or dry. It is medium acid or strongly acid.

The B2 horizon has value of 3 or 4 when moist and 4 or 5 when dry, and it has chroma of 3 to 6 when moist or dry. It is very gravelly sandy loam to extremely gravelly sandy loam and is slightly acid to strongly acid.

The C horizon is slightly acid or neutral.

Squally Series

The Squally series consists of very deep, well drained soils on uplands. Squally soils formed in basaltic landslide debris. Slope is 5 to 65 percent. Elevation is 100 to 1,500 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial-skeletal, mesic Andic Haplumbrepts.

Typical pedon of Squally gravelly silt loam, 5 to 30 percent slopes, in Wahkiakum County, 7 miles northeast of Skamokawa, about 1,700 feet east and 2,550 feet north of the southwest corner of sec. 9, T. 10 N., R. 6 W.

O1-1 inch to 0; partially decomposed leaves and hemlock needles.

A1-0 to 10 inches; dark brown (7.5YR 3/3) gravelly silt loam, brown (7.5YR 5/4) dry; moderate medium and fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common fine and very fine roots; common fine and very fine tubular pores and many very fine interstitial pores; 20 percent pebble-sized fragments of basalt; strongly acid; gradual wavy boundary.

B2-10 to 60 inches; dark reddish brown (5YR 3/4) very gravelly fine sandy loam, brownish yellow (10YR 6/6) dry; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; few fine and very fine roots; many very fine interstitial pores; 55 percent pebble-sized fragments of basalt; strongly acid.

The 10- to 40-inch control section is very gravelly fine sandy loam or extremely gravelly fine sandy loam and averages 50 to 80 percent rock fragments. The umbric epipedon is 10 to 14 inches thick.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 2 or 3 when moist and 3 to 5 when dry, and chroma of 2 to 4 when moist or dry.

The B horizon has hue of 5YR to 10YR when moist or dry, and it has value of 3 or 4 when moist.

Stimson Series

The Stimson series consists of very deep, poorly drained soils in depressional areas on uplands. Stimson soils formed in alluvium. Slope is 0 to 3 percent. Elevation is 500 to 1,500 feet. The average annual precipitation is 60 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are fine-silty, mixed, acid, mesic Typic Humaquepts.

Typical pedon of Stimson silt loam, in Wahkiakum County, 7 miles southeast of Cathlamet, about 750 feet east and 2,100 feet south of the northwest corner of sec. 22, T. 8 N., R. 5 W.

O1-2 inches to 0; partially decomposed leaf litter.

A11-0 to 6 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak very fine and fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; common very fine, fine, medium, and coarse roots; common very fine and fine tubular pores; medium acid; clear wavy boundary.

A12-6 to 11 inches; very dark gray (10YR 3/1) silt loam, light brownish gray (10YR 6/2) dry; weak very fine, fine, and medium subangular blocky structure; slightly hard, very friable, nonsticky and slightly plastic; common very fine, fine, and medium roots; common very fine tubular pores; medium acid; gradual wavy boundary.

B2g-11 to 19 inches; gray (10YR 5/1) silty clay loam, brown (10YR 5/3) when moist and rubbed, light gray (10YR 7/1) when dry, pale brown (10YR 6/3) when dry and rubbed; common medium prominent reddish yellow (7.5YR 6/8) mottles, reddish yellow (5YR 6/8) dry; massive; hard, friable, slightly sticky and slightly plastic; few fine and medium roots; few very fine tubular pores; very strongly acid; gradual wavy boundary.

Cg-19 to 60 inches; grayish brown (10YR 5/2) silty clay loam, yellowish brown (10YR 5/4) when moist and rubbed, light gray (10YR 7/1) when dry, yellow (10YR 7/6) when dry and rubbed; common fine prominent red (2.5YR 4/6) mottles, reddish yellow (5YR 6/8) dry, and many large prominent yellowish brown (10YR 5/8) mottles, reddish yellow (7.5YR 6/6) dry; massive; hard, friable, slightly sticky and slightly plastic; few fine and medium roots; few very fine tubular pores; very strongly acid.

The A horizon has value of 1 to 3 when moist and 5 or 6 when dry, and it has chroma of 1 or 2 when moist and 2 or 3 when dry. It is mottled in some places.

The B horizon has value of 4 or 5 when moist and 6 or 7 when dry, and it has chroma of 1 (2 or 3 when rubbed) when moist or dry.

The C horizon has value of 5 or 6 when moist and 6 or 7 when dry, and it has chroma of 1 to 3 when moist and 1 or 2 when dry. The mottles have hue of 2.5YR to 10YR when moist or dry, value of 4 to 6 when moist and 5 or 6 when dry, and chroma of 6 to 8 when moist or dry. The horizon is silty clay loam or silt loam.

Swem Series

The Swem series consists of very deep, moderately well drained soils on old earthflows. Swem soils formed in basaltic colluvium over marine sediment. Slope is 5 to 65 percent. Elevation is 500 to 1,400 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andaquic Haplumbrepts.

Typical pedon of Swem gravelly silt loam, 5 to 30 percent slopes, in Pacific County, 5 miles northeast of Naselle, about 2,000 feet east and 750 feet south of the northwest corner of sec. 27, T. 11 N., R. 9 W.

O1-1.5 inches to 0.5 inch; loose litter of needles and twigs.

O2-0.5 inch to 0; decomposed litter.

A1-0 to 15 inches; very dark brown (10YR 2/2) gravelly silt loam, very dark grayish brown (10YR 3/2) dry; moderate fine and medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; weakly smeary; few coarse roots, common medium roots, and many very fine roots; few very fine tubular pores; 20 percent angular basalt pebbles; strongly acid; clear wavy boundary.

B21-15 to 28 inches; yellowish brown (10YR 5/6) gravelly silt loam, brownish yellow (10YR 6/6) dry; few fine prominent grayish brown (10YR 5/2) mottles, very pale brown (10YR 8/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few fine and very fine roots; few very fine tubular pores; 20 percent angular basalt pebbles and 10 percent rounded basalt cobbles; medium acid; gradual smooth boundary.

IIB22-28 to 60 inches; yellowish brown (10YR 5/6) silt loam, yellow (10YR 7/6) dry; common medium prominent grayish brown (10YR 5/2) mottles, very pale brown (10YR 8/3) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; few very fine tubular pores; 25 percent fragments of soft siltstone; strongly acid.

The control section is 18 to 27 percent clay. The upper part of the control section is 15 to 35 percent hard pebbles, cobbles, and stone-sized fragments of basalt, and the lower part is 10 to 35 percent fragments of soft siltstone. The profile is medium acid to very strongly acid. Depth to marine siltstone and sandstone is 20 to 40 inches. Hue is 7.5YR or 10YR when moist or dry. The umbric epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 when moist and 2 to 5 when dry, and it has chroma of 2 or 3 when moist or dry.

The B21 horizon has value of 3 to 5 when moist and 5 or 6 when dry, and it has chroma of 4 to 7 when moist or dry. It is gravelly silt loam, gravelly loam, or cobbly loam.

The IIB22 horizon has value of 4 to 6 when moist and 6 or 7 when dry, and it has chroma of 2 to 6 when moist or dry. It is silt loam or silty clay loam.

Sylvia Series

The Sylvia series consists of very deep, moderately well drained soils in old lakebeds on uplands. Sylvia soils formed in lacustrine silt and clay. Slope is 1 to 5 percent. Elevation is 20 to 200 feet. The average annual precipitation is 80 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andaquic Haplumbrepts.

Typical pedon of Sylvia silt loam, in Grays Harbor County, 10 miles south of Cosmopolis, about 100 feet south and 100 feet west of the northeast corner of sec. 33, T. 16 N., R. 9 W.

O1-3 inches to 1 inch; accumulation of moss, rotted wood, needles, and twigs.

O2-1 inch to 0; decomposed organic matter.

A1-0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; strong medium and coarse granular structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; common coarse roots and few very fine and fine roots; many very fine tubular pores; extremely acid; gradual smooth boundary.

A3-9 to 17 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine and fine roots; common very fine tubular pores; very strongly acid; clear wavy boundary.

B21-17 to 25 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; common fine distinct strong brown (7.5YR 5/8) and very dark grayish brown (10YR 3/2) mottles, reddish yellow (7.5YR 6/8) and grayish brown (10YR 5/2) dry; weak fine and medium subangular blocky

structure; hard, friable, sticky and plastic; weakly smeary; few very fine roots; common very fine tubular pores; very strongly acid; gradual wavy boundary.

B22-25 to 60 inches; yellowish brown (10YR 5/6) silty clay loam, brownish yellow (10YR 6/6) dry; many fine and medium distinct strong brown (7.5YR 5/8) mottles, reddish yellow (7.5YR 6/8) dry, and common fine distinct very dark grayish brown (10YR 3/2) mottles, grayish brown (10YR 5/2) dry; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; weakly smeary; few very fine roots; common very fine tubular pores; very strongly acid.

The solum is 40 inches to more than 60 inches thick. The 10- to 40-inch control section is 25 to 50 percent clay. It has few if any rock fragments. The umbric epipedon is 12 to 20 inches thick.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist or dry. It is extremely acid or very strongly acid.

The B horizon has hue of 7.5YR or 10YR when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 3 to 6 when moist or dry. It is clay loam, silty clay loam, or silty clay. It is strongly acid or very strongly acid.

Tebo Series

The Tebo series consists of very deep, well drained soils on uplands. Tebo soils formed in glacial drift derived dominantly from basalt. Slope is 5 to 65 percent. Elevation is 200 to 800 feet. The average annual precipitation is 50 to 70 inches, the average annual air temperature is about 52 degrees F, and the average growing season is 200 to 240 days.

These soils are fine-loamy, mixed, mesic Dystric Xerochrepts.

Typical pedon of Tebo silt loam, 5 to 30 percent slopes, in Grays Harbor County, 1.5 miles east of McCleary, about 1,600 feet east and 200 feet north of the southwest corner of sec. 7, T. 18 N., R. 4 W.

O1-3.5 to 1.5 inches; accumulation of needles and twigs.

O2-1.5 inches to 0; accumulation of decayed needles and twigs.

A1-0 to 9 inches; dark reddish brown (5YR 3/3) silt loam, dark brown (7.5YR 4/4) dry; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots, common medium roots, and few coarse roots; common very fine tubular pores; 5 percent rounded and angular pebbles and 5 percent cobbles; medium acid; clear smooth boundary.

A3-9 to 13 inches; dark reddish brown (5YR 3/4) gravelly clay loam, yellowish red (5YR 5/6) dry; weak fine subangular blocky structure parting to moderate fine and medium granular; slightly hard, friable, slightly sticky and plastic; many very fine and fine roots, common medium roots, and few coarse roots; many very fine tubular and interstitial pores; 10 percent rounded and angular pebbles and 15 percent angular cobbles; medium acid; clear smooth boundary.

B21-13 to 30 inches; reddish brown (5YR 4/4) cobbly silty clay loam, yellowish red (5YR 5/6) dry; moderate fine subangular blocky structure parting to weak very fine subangular blocky; slightly hard, friable, sticky and plastic; common very fine roots, many fine roots, and few medium and coarse roots; many very fine tubular and interstitial pores; 10 percent rounded and angular pebbles and 15 percent angular cobbles; strongly acid; clear smooth boundary.

B22-30 to 48 inches; dark brown (7.5YR 4/4) cobbly silty clay loam, strong brown (7.5YR 5/6) dry; weak fine subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine and fine roots, common medium roots, and few coarse roots; many very fine tubular and interstitial pores; 10 percent rounded and angular pebbles and 10 percent angular cobbles; very strongly acid; gradual smooth boundary.

B31-48 to 57 inches; dark yellowish brown (10YR 4/4) cobbly clay loam, brown (7.5YR 5/4) dry; weak fine subangular blocky structure; slightly hard, friable, sticky and plastic; few fine and medium roots; common very fine tubular pores; 10 percent rounded and angular pebbles and 20 percent angular cobbles; very strongly acid; clear smooth boundary.

B32-57 to 60 inches; dark yellowish brown (10YR 4/4) gravelly clay loam, yellowish brown (10YR 5/4) dry; common fine distinct yellowish red (5YR 4/6) iron stains and black (N 2/) manganese coatings on ped surfaces, common fine prominent yellowish red (10YR 5/8) iron stains and black (N 2/) manganese coatings on ped surfaces when dry; strong angular blocky structure; hard, friable, sticky and plastic; few very fine roots; common very fine tubular pores; 15 percent rounded and angular pebbles and 5 percent angular cobbles; very strongly acid.

The 10- to 40-inch control section averages 10 to 35 percent coarse fragments and 27 to 35 percent clay. Angular basalt pebbles and cobbles and smooth glacial drift pebbles are throughout the profile. The profile is medium acid to very strongly acid throughout.

The A horizon has hue of 5YR or 7.5YR when moist, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 2 to 6 when dry.

The B horizon has hue of 5YR, 7.5YR, or 10YR when moist, and it has value of 5 or 6 when dry. It is gravelly silty clay loam, cobbly silty clay loam, gravelly clay loam, or cobbly clay loam.

Traham Series

The Traham series consists of moderately deep, well drained soils on uplands. Traham soils formed in material weathered from basalt. Slope is 5 to 90 percent. Elevation is 1,100 to 2,200 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial-skeletal, mesic Andic Haplumbrepts.

Typical pedon of Traham very gravelly loam, 65 to 90 percent slopes, in Pacific County, 8 miles northwest of Raymond, about 2,000 feet west and 1,500 feet north of the southeast corner of sec. 29, T. 15 N., R. 9 W.

O1-4 to 3 inches; accumulation of roots, needles, twigs, and rotten wood.

O2-3 inches to 0; decomposed twigs, needles, and wood.

Al 1-0 to 2 inches; dark brown (7.5YR 3/2) very gravelly loam, dark brown (7.5YR 4/4) dry; strong medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common medium roots and many fine and very fine roots; many very fine interstitial pores; 35 percent pebbles and 5 percent cobbles; strongly acid; clear wavy boundary.

A12-2 to 11 inches; dark reddish brown (5YR 3/3) very gravelly loam, dark brown (7.5YR 4/4) dry; strong fine and very fine subangular blocky structure; soft, very friable, nonsticky and slightly plastic; weakly smeary; common medium, fine, and very fine roots and few coarse roots; many very fine interstitial pores; 35 percent pebbles and 5 percent cobbles; medium acid; clear smooth boundary.

B21-11 to 26 inches; dark reddish brown (5YR 3/4) very gravelly clay loam, reddish brown (5YR 4/4) dry; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few coarse, medium, and fine roots; many fine interstitial pores and few very fine tubular pores; 40 percent pebbles and 5 percent cobbles; medium acid; clear smooth boundary.

B22-26 to 31 inches; dark brown (7.5YR 4/4) very gravelly clay loam, strong brown (7.5YR 5/6) dry; moderate very fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; weakly smeary; few very fine roots; few very fine tubular pores; 55 percent pebbles and 5 percent cobbles; medium acid; abrupt smooth boundary.

R-31 inches; fractured basalt; few very fine roots in fractures.

Depth to fractured basalt ranges from 24 to 36 inches. The profile is strongly acid or medium acid throughout. The umbric epipedon is 10 to 15 inches thick.

The A horizon has hue of 5YR or 7.5YR when moist or dry, value of 2 or 3 when moist, and chroma of 2 or 3 when moist.

The B horizon has hue of 5YR or 7.5YR when moist or dry, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 4 to 6 when dry. It is very gravelly clay loam or very gravelly silty clay loam and is 30 to 55 percent pebbles and 5 to 10 percent cobbles.

Vesta Series

The Vesta series consists of very deep, well drained soils on uplands. Vesta soils formed in material weathered from basalt. Slope is 1 to 65 percent. Elevation is 100 to 1,800 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is 46 to 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Vesta silt loam, 8 to 30 percent slopes, in Pacific County, 5 miles northeast of Nemah, about 300 feet east and 1,900 feet south of the northwest corner of sec. 6, T. 12 N., R. 9 W.

O1-1 inch to 0; accumulation of needles, twigs, and moss.

A1-0 to 13 inches; dark reddish brown (5YR 3/3) silt loam, brown (7.5YR 5/4) dry; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; weakly smeary; many fine and very fine roots; common fine and very fine tubular pores; strongly acid; gradual wavy boundary.

B21-13 to 26 inches; dark brown (7.5YR 4/4) silty clay loam, light brown (7.5YR 6/4) dry; moderate fine and medium subangular blocky structure; slightly hard, very friable, sticky and slightly plastic; weakly smeary; common fine and very fine roots and few coarse roots; many fine and very fine tubular pores; medium acid; gradual wavy boundary.

B22-26 to 37 inches; dark brown (7.5YR 4/4) silty clay loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; weakly smeary; common fine and very fine roots; many fine and very fine tubular pores; medium acid; clear smooth boundary.

B23-37 to 60 inches; strong brown (7.5YR 5/6) silty clay, reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure; hard, friable, sticky and plastic; weakly smeary; few fine and very fine roots; common fine and very fine tubular pores; medium acid.

The solum is 50 inches to more than 60 inches thick. The 10- to 40-inch control section is 35 to 55 percent clay and 0 to 15 percent fragments of basalt. The soil is strongly acid or medium acid throughout. The umbric epipedon is 11 to 16 inches thick.

The A horizon has hue of 5YR or 7.5YR when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist.

The B horizon has hue of 5YR to 10YR when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 4 to 6 when moist or dry. It is silty clay loam or silty clay.

Westport Series

The Westport series consists of very deep, excessively drained soils on uplands. Westport soils formed in sand. Slope is 3 to 10 percent. Elevation is 10 to 50 feet. The average annual precipitation is 60 to 80 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are mixed, mesic Typic Udipsamments.

Typical pedon of Westport fine sand, 3 to 10 percent slopes, in Grays Harbor County, 2 miles north of Grayland, about 500 feet east and 1,300 feet north of the southwest corner of sec. 30, T. 16 N., R. 11 W.

O1-1 /2 to 1 /4 inch; moss, grass, leaves, and stems.
O2-1/4 inch to 0; decayed grass, moss, and needles.
A1-0 to 7 inches; very dark grayish brown (10YR 3/2) fine sand, dark grayish brown (2.5Y 4/2) dry; single grain; loose; many fine roots; many pores; strongly acid; clear smooth boundary.
AC-7 to 16 inches; dark grayish brown (2.5Y 4/2) fine sand, light brownish gray (2.5Y 6/2) dry; single grain; loose; few fine roots; many pores; iron stains along root channels; medium acid; clear wavy boundary.
C-16 to 60 inches; olive gray (5Y 4/2) fine sand, light olive gray (5Y 6/2) dry; single grain; loose; many pores; medium acid.

The solum is 7 to 20 inches thick. The profile is very strongly acid to medium acid throughout.

The A1 horizon has hue of 10YR or 2.5Y when moist or dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 1 or 2 when moist or dry.

The AC horizon has value of 3 or 4 when moist and 4 to 6 when dry. It is fine sand or loamy fine sand.

The C horizon has hue of 2.5Y or 5Y when moist or dry, and it has value of 3 or 4 when moist and 5 or 6 when dry. It is fine sand or loamy fine sand.

Willaby Series

The Willaby series consists of very deep, moderately well drained soils on benches and terraces. Willaby soils formed in glacial drift. Slope is 1 to 15 percent. Elevation is 100 to 500 feet. The average annual precipitation is 110 to 150 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are fine, mixed, mesic Umbric Dystrochrepts.

Typical pedon of Willaby silt loam, 1 to 15 percent slopes, in Grays Harbor County, 3 miles north of Humptulips, about 2,540 feet north and 250 feet west of the southeast corner of sec. 33, T. 21 N., R. 10 W.

O1-2.5 inches to 0.25 inch; accumulation of leaves, needles, twigs, and moss.
O2-0.25 inch to 0; decomposed organic material.
A1-0 to 6 inches; dark reddish brown (5YR 3/3) silt loam, dark brown (7.5YR 4/4) dry; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; common medium and coarse roots; many fine tubular and interstitial pores; about 2 percent rounded pebbles; very strongly acid; clear smooth boundary.
A3-6 to 11 inches; dark brown (7.5YR 3/4) silt loam, strong brown (7.5YR 5/6) dry; strong very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots and few medium and coarse roots; many very fine and fine interstitial pores; 2 percent angular and rounded pebbles; very strongly acid; abrupt smooth boundary.
B21-11 to 25 inches; strong brown (7.5YR 5/6) silty clay, reddish yellow (7.5YR 6/6) dry; moderate fine and medium subangular blocky structure; hard, friable, sticky and plastic; common very fine roots and few fine, medium, and coarse roots; many very fine tubular and interstitial pores; 5 percent angular and rounded pebbles; very strongly acid; clear smooth boundary.
IIB22-25 to 47 inches; yellowish brown (10YR 5/6) very gravelly silty clay, brownish yellow (10YR 6/6) dry; moderate fine subangular blocky structure; hard, friable, sticky and plastic; few very fine and fine roots; many very fine tubular and interstitial pores; 40 percent rounded and angular pebbles and 5 percent cobbles; very strongly acid; gradual smooth boundary.
IIC-47 to 60 inches; yellowish brown (10YR 5/4) extremely gravelly silty clay loam, very pale brown (10YR 7/4) dry; common fine distinct yellowish red (5YR 5/8) mottles, reddish yellow (5YR 6/8) dry; massive; hard, friable, sticky and plastic; common very fine interstitial pores; 60 percent angular and rounded pebbles and 10 percent cobbles; very strongly acid.

Depth to the IIC horizon ranges from 40 to 60 inches or more. The control section averages 15 to 35 percent hard rock fragments and 35 to 50 percent clay.

The A horizon has hue of 5YR to 10YR when moist, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 3 or 4 when moist and 4 to 6 when dry.

The B horizon has hue of 7.5YR or 10YR when moist or dry, and it has value of 5 or 6 when moist. It is silty clay or silty clay loam. The content of hard rock fragments ranges from 2 to 15 percent.

The IIB horizon has hue of 10YR or 7.5YR when moist or dry, and it has value of 5 or 6 when moist. It is gravelly silty clay loam, gravelly silty clay, very gravelly silty clay loam, or very gravelly silty clay. It is 15 to 60 percent hard angular and rounded pebbles and cobbles.

The IIC horizon has value of 5 or 6 when moist and 6 or 7 when dry, and it has chroma of 4 to 6 when moist or dry. It is extremely gravelly silty clay or extremely gravelly silty clay loam and is 60 to 90 percent angular and rounded pebbles and cobbles. The IIC horizon is cemented or compacted below a depth of 40 inches in some places.

Willapa Series

The Willapa series consists of very deep, moderately well drained soils on marine terraces. Willapa soils formed in highly stratified marine sediment. Slope is 1 to 70 percent. Elevation is sea level to 400 feet. The average annual precipitation is 80 to 100 inches, the average annual air temperature is 46 to 48 degrees F, and the average growing season is 180 to 220 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Willapa silt loam, 1 to 8 percent slopes, in Pacific County, 8 miles southwest of South Bend, about 500 feet east and 200 feet north of the southwest corner of sec. 3, T. 13 N., R. 10 W.

O1-1 inch to 0; accumulation of leaves and twigs.

A11-0 to 10 inches; dark brown (7.5YR 3/2) silt loam, grayish brown (10YR 5/2) dry; strong fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; weakly smeary; common medium roots and many fine and very fine roots; many very fine interstitial pores; strongly acid; gradual smooth boundary.

A12-10 to 18 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and plastic; weakly smeary; common very fine and fine roots; common very fine and fine tubular pores; strongly acid; clear smooth boundary.

B2-18 to 43 inches; dark yellowish brown (10YR 4/4) silty clay loam, light yellowish brown (10YR 6/4) dry; common fine and medium prominent strong brown (7.5YR 5/8) mottles, reddish yellow (7.5YR 6/8) dry: weak fine subangular blocky structure; hard, firm, sticky and plastic; weakly smeary; few very fine roots; common very fine and fine tubular pores; strongly acid; clear smooth boundary.

C-43 to 60 inches; pale brown (10YR 6/3) silty clay loam, very pale brown (10YR 7/3) dry; many fine and medium prominent strong brown (7.5YR 5/8) mottles, reddish yellow (7.5YR 6/8) dry and common fine and medium distinct grayish brown (2.5Y 5/2) mottles, light gray (2.5Y 7/2) dry; massive; hard, firm, sticky and plastic; weakly smeary; few very fine roots; few very fine tubular pores; strongly acid.

The solum is 35 to 50 inches thick. The profile is medium acid to very strongly acid throughout.

The A horizon has hue of 7.5YR or 10YR when moist or dry, value of 3 when moist and 4 or 5 when dry, and chroma of 2 or 3 when moist and 2 to 4 when dry.

The B horizon has hue of 5YR to 10YR when moist or dry, value of 3 to 5 when moist and 5 to 7 when dry, and chroma of 4 to 6 when moist or dry. It is silt loam or silty clay loam that is less than 35 percent clay. In some places, the lower part of the B horizon has mottles that have chroma of 2 or less.

The C horizon has hue of 5Y to 10YR when moist or dry, value of 4 to 6 when moist and 6 or 7 when dry, and chroma of 3 to 6 when moist or dry. It is mottled silt loam or silty clay loam.

Wishkah Series

The Wishkah series consists of very deep, somewhat poorly drained soils in large basins and along small drainageways on glacial outwash plains. Drainage has been altered by ditching and tiling. Wishkah soils formed in glacial lacustrine sediment. Slope is 0 to 2 percent. Elevation is 50 to 500 feet. The average annual precipitation is 80 to 120 inches, the average annual air temperature is about 48 degrees F, and the average growing season is 180 to 220 days.

These soils are fine, mixed, mesic Aquic Dystrochrepts.

Typical pedon of Wishkah silty clay loam, in Grays Harbor County, 3 miles southeast of Pacific Beach, about 1,200 feet east and 600 feet north of the southwest corner of sec. 25, T. 20 N., R. 12 W.

O1-5 inches to 0; partially decomposed needles, twigs, and rotted wood.

A1-0 to 6 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; strong medium and coarse subangular blocky structure; hard, friable, slightly sticky and plastic; common fine, medium, and coarse roots; many fine and very fine tubular and interstitial pores; extremely acid; clear wavy boundary.

B21-6 to 10 inches; dark yellowish brown (10YR 4/4) silty clay, yellowish brown (10YR 5/4) dry; common fine and medium distinct yellowish red (5YR 5/8) mottles; moderate medium subangular blocky

structure; very hard, firm, sticky and plastic; few fine roots; common fine and very fine tubular and interstitial pores; very strongly acid; gradual smooth boundary.

B22-10 to 26 inches; yellowish brown (10YR 5/4) clay, light yellowish brown (10YR 6/4) dry; common fine and medium distinct yellowish red (5YR 5/8) and light brownish gray (2.5Y 6/2) mottles; moderate medium subangular blocky structure; very hard, firm, very sticky and very plastic; few fine roots; common very fine tubular and interstitial pores; extremely acid; clear smooth boundary.

B23g-26 to 39 inches; grayish brown (2.5Y 5/2) clay, light brownish gray (2.5Y 6/2) dry; many fine and medium prominent yellowish red (5YR 5/8) mottles; moderate fine and very fine subangular blocky structure; very hard, firm, very sticky and very plastic; few fine roots; few very fine tubular pores; extremely acid; clear smooth boundary.

Cg-39 to 60 inches; light olive gray (5Y 6/2) clay, light gray (5Y 7/2) dry; many fine and medium prominent yellowish red (5YR 5/8) mottles; massive; very hard, firm, very sticky and very plastic; few very fine tubular pores; extremely acid.

The solum is 30 to 55 inches thick. The profile is extremely acid or very strongly acid. The 10- to 40-inch control section is 40 to 55 percent clay. Depth to mottles that have chroma of 2 or less ranges from 10 to 20 inches.

The A horizon has hue of 7.5YR or 10YR when moist and 10YR or 2.5Y when dry, value of 2 or 3 when moist and 4 or 5 when dry, and chroma of 2 to 4 when moist or dry.

The B horizon has hue of 10YR, 2.5Y, or 5Y when moist or dry, and it has value of 4 to 6 when moist and 5 to 8 when dry. The upper part of the horizon has chroma of 3 or 4 when moist or dry, and the lower part has chroma of 1 or 2 when moist or dry. The horizon is silty clay or clay.

The C horizon has hue of 2.5Y, 5Y, or N when moist or dry, value of 5 or 6 when moist and 6 to 8 when dry, and chroma of less than 2 when moist or dry. It is silty clay or clay. In some places, the C horizon is as much as 50 percent coarse fragments. At a depth of more than 40 inches, it is stratified with material that is coarser textured than silty clay.

Yaquina Series

The Yaquina series consists of very deep, somewhat poorly drained soils in depressional areas or basinlike areas between sand dunes. Yaquina soils formed in sand. Slope is 0 to 1 percent. Elevation is 10 to 50 feet. The average annual precipitation is 70 to 90 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are sandy, mixed, mesic Aquic Haplorthods.

Typical pedon of Yaquina loamy fine sand, in Pacific County, 3 miles north of Long Beach, about 1,400 feet east and 900 feet north of the southwest corner of sec. 4, T. 10 N., R. 11 W.

O1-112 to 1 /4 inch; needles, twigs, and leaves.

O2-1/4 inch to 0; decomposed needles, twigs, and leaves.

A2-0 to 4 inches; very dark grayish brown (10YR 3/2) loamy fine sand, gray (10YR 5/1) dry; single grain; soft, very friable, nonsticky and nonplastic; many coarse, medium, and fine roots; many very fine and fine tubular pores; very strongly acid; abrupt smooth boundary.

B&A-4 to 9 inches; dark reddish gray (5YR 4/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; many discontinuous vertical tongues of A2 material extending from horizon above; single grain; soft, very friable, nonsticky and nonplastic; few fine roots; many very fine and fine tubular pores; discontinuous platy lenses of firm bog iron that is hard when dry; very strongly acid; clear smooth boundary.

B21ir-9 to 17 inches; dark reddish gray (5YR 4/2) fine sand, dark brown (7.5YR 4/2) dry; single grain; soft, very friable, nonsticky and nonplastic; many very fine and fine tubular pores; very strongly acid; clear smooth boundary.

B22ir-17 to 24 inches; dark brown (10YR 4/3) fine sand, pale brown (10YR 6/3) dry; single grain; soft, very friable, nonsticky and nonplastic; many very fine and fine tubular pores; common medium distinct yellowish red (5YR 4/8) and grayish brown (2.5Y 5/2) thin lenses of bog iron; strongly acid; gradual wavy boundary.

C-24 to 60 inches; olive brown (2.5Y 4/4) fine sand, light brownish gray (2.5Y 6/2) dry; single grain; soft, very friable, nonsticky and nonplastic; many very fine and fine tubular pores; common medium fine vertical streaks of bog iron; strongly acid.

Unless the profile is artificially drained, it is saturated with water most of the year. The solum is underlain by many feet of variegated sand.

The A2 horizon has value of 3 to 5 when moist and chroma of 1 or 2 when moist or dry.

The Bir horizon has hue of 5YR to 10YR when moist or dry, value of 4 or 5 when moist and 5 or 6 when dry, and chroma of 2 or 3 when moist or dry. Firm or very firm, reddish, weakly cemented nodules and thin, very firm lenses are common throughout the Bir horizon.

In the Yaquina soils in this survey area, the difference between the mean soil temperature in summer and the mean soil temperature in winter at a depth of 20 inches is greater than is defined as the range for the series.

This difference, however, does not significantly affect use and management.

Zenker Series

The Zenker series consists of very deep, well drained soils on uplands. Zenker soils formed in material weathered from sandstone. Slope is 8 to 90 percent. Elevation is 50 to 1,600 feet. The average annual precipitation is 70 to 110 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Zenker silt loam, 8 to 30 percent slopes, in Wahkiakum County, 8 miles northwest of Cathlamet, about 1,300 feet west and 300 feet south of the northeast corner of sec. 6, T. 9 N., R. 5 W.

A1-0 to 11 inches; very dark brown (10YR 2/2) silt loam, dark yellowish brown (10YR 3/4) dry; moderate medium and fine granular structure; soft, very friable, slightly sticky and slightly plastic; weakly smeary; many fine and very fine roots; many fine and very fine tubular pores; 60 percent pebble-sized fragments of soft sandstone; strongly acid; gradual wavy boundary.

B1-11 to 17 inches; very dark grayish brown (10YR 3/2) silt loam, dark yellowish brown (10YR 4/4) dry; weak medium and fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; weakly smeary; common fine and very fine roots; many fine and very fine tubular pores; 10 percent cobble-sized fragments of soft sandstone and 50 percent pebble-sized fragments of soft sandstone; medium acid; clear wavy boundary.

B2-17 to 60 inches; dark brown (10YR 4/3) loam, yellowish brown (10YR 5/4) dry; weak medium and fine subangular blocky structure; soft, friable, slightly sticky and slightly plastic; weakly smeary; few fine and very fine roots; common very fine tubular pores; 10 percent cobble-sized fragments of soft sandstone and 55 percent pebble-sized fragments of soft sandstone; medium acid.

The solum is 40 inches to more than 60 inches thick. The 10- to 40-inch control section is 20 to 27 percent clay. The profile is medium acid to extremely acid throughout. The umbric epipedon is 10 to 20 inches thick.

The A horizon has hue of 10YR or 7.5YR when moist or dry, value of 2 or 3 when moist and 3 or 4 when dry, and chroma of 2 or 3 when moist and 2 to 4 when dry.

The B2 horizon has value of 3 or 4 when moist and 4 or 5 when dry. It is loam or silt loam and is 10 to 15 percent cobble-sized fragments of soft sandstone and 50 to 60 percent pebble-sized fragments of soft sandstone.

Zyzyl Series

The Zyzyl series consists of deep, well drained soils on mountainsides. Zyzyl soils formed in material weathered from basalt. Slope is 8 to 90 percent. Elevation is 600 to 1,800 feet. The average annual precipitation is 120 to 180 inches, the average annual air temperature is about 50 degrees F, and the average growing season is 200 to 240 days.

These soils are medial, mesic Andic Haplumbrepts.

Typical pedon of Zyzyl gravelly loam, 65 to 90 percent slopes, in Grays Harbor County, 30 miles north of Montesano, about 1,700 feet north and 500 feet east of the southwest corner of sec. 12, T. 21 N., R. 7 W.

O1-2 inches to 0; accumulation of leaves, twigs, and rotted wood.

A1-0 to 7 inches; dark brown (7.5YR 3/2) gravelly loam, dark brown (10YR 4/3) dry; strong very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine, fine, medium, and coarse roots; many very fine tubular and interstitial pores; 20 percent angular hard basalt pebbles; strongly acid; clear wavy boundary.

B21-7 to 16 inches; dark brown (7.5YR 3/2) gravelly loam, dark yellowish brown (10YR 4/4) dry; moderate fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; many very fine and fine roots and common medium . and coarse roots; common very fine interstitial pores; 20 percent angular soft basalt pebbles and 20 percent angular hard basalt pebbles; medium acid; gradual wavy boundary.

B22-16 to 29 inches; dark reddish brown (5YR 3/3) gravelly sandy loam, strong brown (7.5YR 5/6) dry; moderate fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; weakly smeary; common very fine and fine roots and few medium and coarse roots; common very fine tubular and interstitial pores; 45 percent angular soft basalt pebbles and 25 percent angular hard basalt pebbles; medium acid; abrupt smooth boundary.

C-29 to 45 inches; reddish brown (5YR 4/3) gravelly sandy loam, strong brown (7.5YR 5/6) dry; massive; soft, very friable nonsticky and nonplastic; weakly smeary; common very fine roots; common fine interstitial pores; 20 percent angular hard basalt pebbles and 70 percent angular soft basalt pebbles; medium acid; clear wavy boundary.

Cr-45 inches; highly fractured, loose chloritized basalt; fractures are less than 10 centimeters apart; easily dug with a spade.

The solum is 20 to 40 inches thick. Depth to consolidated bedrock is more than 60 inches. The profile is strongly acid or medium acid throughout.

The A1 horizon has hue of 5YR or 7.5YR when moist and 7.5YR or 10YR when dry, value of 4 or 5 when dry, and chroma of 2 or 3 when moist or dry.

The B2 horizon has hue of 5YR or 7.5YR when moist and 7.5YR or 10YR when dry, value of 3 or 4 when moist and 4 or 5 when dry, and chroma of 2 to 4 when moist and 4 to 6 when dry. It is gravelly loam or gravelly sandy loam and is 20 to 30 percent hard pebbles and 20 to 50 percent soft pebbles.

The C horizon has hue of 5YR or 7.5YR when moist or dry, value of 5 or 6 when dry, and chroma of 3 or 4 when moist and 4 to 6 when dry. It is 10 to 25 percent hard pebbles and 60 to 75 percent soft pebbles.

Formation of the Soils

Soil is a product of soil-forming processes acting on material deposited or accumulated by geologic agents. The important factors in soil formation are parent material, climate, living organisms, topography, and time.

Factors of Soil Formation

Climate and living organisms, particularly vegetation, are the active factors in soil formation. Their effect on the parent material is modified by topography of the land and by the length of time the parent material has been in place. The relative importance of each factor differs from place to place. Occasionally, one factor dominates and fixes most of the properties of the soil, but normally all five factors interact to determine the kind of soil that develops in any given place. The factors of soil formation are discussed in this section.

Parent Material

By Alan Fiksdahl, geologist, Washington State Department of Natural Resources.

In this survey area the parent materials are diverse. In the mountainous areas they include material derived from basalt, sandstone, shale, and marine and nonmarine siltstone, and along the coastal marine terraces they include material derived from sedimentary rock, silt, clay, and sand. Younger continental and alpine glacial deposits are in the northern and central parts of Grays Harbor County. Coastal beach deposits and alluvium on the stream bottoms are the most recent depositional parent materials in the survey area (4, *12, 19, 20, 21, 25).*

Eocene marine basalt, which includes the Olympic Mountain Crescent Formation, is the dominant parent material of the Bunker, Knappton, Lates, and Murnen soils. The Bunker and Knappton soils formed in material derived from marine basalt interbedded with volcanic breccia and sediment. The Bunker soils are associated with landflows. Hillsides in areas of these soils are unstable because the basalt overlies tuffaceous sediment and because instability is produced by this contact (5, 24).

Marine sediment was deposited along a fluctuating shoreline in the western part of Washington during the Eocene and Miocene. At this time of continental movement, large deposits of clay, silt, and sand were reworked by tides in this environment. The sediment was derived from an ancient volcanic mountain range to the east. During the depositional phase, thousands of feet of tuffaceous sediment were buried. This sediment has hardened into claystone, siltstone, and sandstone. It outcrops throughout the survey area. It is now highly dissected by erosion, and deep soils have formed in it. The Lytell and Astoria soils formed in material derived from tuffaceous siltstone and fine sandstone. The Lytell soils commonly are in areas of mass movement and are underlain by partially consolidated siltstone. The Zenker and Elochoman soils formed in material derived from moderately hard siltstone and sandstone.

Wave-cut marine terraces bordering the coast in Pacific County and Grays Harbor County Area formed as the sea level changed during different geologic periods. The Willapa and Newskah soils formed on these landforms in material derived from marine sediment and bedrock.

Soil-forming material in the northern half of Grays Harbor County has been influenced significantly by continental and alpine glaciers. Several large glaciers from Canada filled the Puget Sound region in the western part of Washington during the Pleistocene, and they reached as far as northeastern Grays Harbor County. They deposited till and outwash in these areas. In concert with the continental glaciation, alpine glaciation filled most of the valleys of the Olympic Mountains. Large areas of alpine glacial sediment, predominantly basaltic lithologies from the Olympic Mountains, were deposited across the northern part of Grays Harbor County. Sea level fluctuations and terrace formation were associated with these glacial events. The parent material of the Hoquiam and Le Bar soils consists of glacial till and outwash on marine and outwash terraces. Willaby and Halbert soils formed in alpine till from the Olympic Mountains. In the northeastern part of Grays Harbor County, where continental glaciers overrode the basalt, the Tebo and Schneider soils formed in till mixed with residuum derived from basalt *(17, 18).*

Seven to 26 million years ago, during the Miocene, the sedimentary rock was partially covered by basalt of the Columbia River Group; however, subsequent erosion has stripped the basalt in most areas and much of the sedimentary rock is now exposed. Remnants of these basalt flows now form upland surfaces in parts of Wahkiakum and Pacific Counties and provide the parent

material for the Raught and Germany soils. The Cathlamet soils formed in mass movement debris and associated fragments of basalt and in the soft sandstone that underlies the basalt *(10, 13, 39, 40).*

When the Puget Lowland was occupied by the continental glacier, the Chehalis Valley acted as a meltwater drainageway. Large volumes of sediment-laden outwash flowed from the Puget Sound region to the Pacific Ocean by way of this valley, resulting in the formation of outwash terraces and deposition of alluvial sand and gravel on the valley bottom. The Chehalis, Skamo, and Spanaway soils formed in these coarse textured, well drained deposits.

Recent deposits along the coast include tidal, alluvial, and eolian material. Silt and clay on tidal flats in estuaries are the parent material of the Ocosta and Sauvie soils, and beach dune deposits are the parent material of the Yaquina and Netarts soils.

Throughout the survey area local alluvium in valleys and along bottoms is the parent material for the Grehalem and Rennie soils.

Climate

Differences in climate are directly or indirectly responsible for variations in plant and animal life and for major soil differences. Climate affects the weathering of rocks and the removal and redisposition of material by water, wind, and glaciers. It also determines the rate of percolation of water through the soil.

The survey area has a marine climate. Summers are cool and dry, and winters are mild but wet and cloudy. Rainfall is heavier and temperatures are lower at the higher elevations in the mountains than in the valleys. Rains, however, are gentle, and they moisten the soil much more effectively than torrential downpours. The rainwater soaks into the soil and percolates downward. In regions where humidity is high, the soils are more highly leached than in semiarid and desert regions. For this reason, most of the bases have been leached out and the soils in the survey area are generally acid.

Climate has a marked effect on the productivity and fertility of soils. Soils such as those of the Chehalis series have an average annual rainfall of 60 inches and generally are more fertile than similar soils, such as those of the Grehalem series, that receive 80 inches or more of annual rainfall. At the higher elevations, the growing season is shorter, frost occurs later in spring and earlier in fall, and the average annual temperature is less than at lower elevations. Soils at higher elevations are less productive than those at lower elevations. The Boistfort soils at elevations below 1,800 feet, for example, produce about 181 cubic feet of Douglas-fir per acre per year, but the similar Murnen soils at elevations of 1,800 to 2,700 feet produce only about 139 cubic feet of Douglas-fir per acre per year.

Living Organisms

All life on and in the soil affects soil formation. The raw soil material is first invaded by simple forms of life, such as bacteria and fungi, that grow and multiply. Mosses and lichens appear, followed by grasses, shrubs, and trees.

Plant and animal life furnish organic matter and bring plant nutrients from the lower layers to the upper layers. Dead leaves and trunks of grasses and trees drop on the surface of the soil, and these furnish an enormous quantity of organic material over a long period. The roots of these plants permeate the soil to a depth of many feet in some areas and make it more porous. The decay of roots, especially those of grasses, provides a large amount of organic matter. The organic material from grass and leaves is eaten by worms and is thus mixed with the mineral soil material.

Deep-rooted plants bring water from the deeper horizons to the surface and into the stems, trunks, and leaves of the plants. This water brings with it a certain amount of dissolved mineral material. When the leaves fall and the plants themselves decay, these minerals are returned to the surface of the soil. This process, then, brings important nutrients and parent material from the deeper horizons to the surface of the soil and enriches the surface layer.

Soils that formed under grass and bracken, both of which have fibrous, deep-reaching roots, have a very dark brown to black surface layer. The Spanaway and Bear Prairie soils formed under a partial cover of bracken. Soils that formed under coniferous and deciduous vegetation generally have a very dark grayish brown to brown surface layer. An example is Aabab soils.

The decay of forest debris causes the formation of organic acids of various kinds, including carbonic acid. These acids in solution hasten the leaching processes of soils and soil material, so that basic elements are rapidly leached away. Most forested soils in humid regions are medium acid to strongly acid. An example is the Knappton soils.

An important process in humid regions where there is a great amount of leaching is nutrient circulation. Nutrients released from organic material through decay are leached from the surface and are carried downward by percolating water. Plant roots intercept the downward moving water and carry the water and dissolved nutrients back up to the plants.

The remains of sedges, rushes, moss, Labrador tea, and other plants that tolerate wetness have added to the accumulation of peat in bog areas. Seastrand mucky peat formed in these areas.

Animals convert plant remains into organic soil matter. They eat the plants, and the waste is returned to the soil where it is further transformed into organic matter.

Burrowing animals, such as mice, moles, and mountain beaver, mix various horizons of the soils and thus supply a certain amount of fresh parent material to the surface layer, which have been leached of plant nutrients. In places the steep and very steep Bunker soils have been subjected to mixing and churning by the mountain beaver. Earthworms feed on organic soil matter and enrich the soil. The burrows of worms and small animals in many places reach deeply into the soil, and the excavated material is spread out over the surface. When the burrows are abandoned, the cavities are filled with surface soil rich in organic material. It then becomes possible for roots to grow rapidly through some of this relatively rich material and to penetrate more deeply into the soil than would otherwise be possible.

Micro-organisms play an important part in the development of soils. They change raw vegetable material into organic matter. Bacteria and various kinds of fungi cause dead leaves and other plant remains to decay, and they are then incorporated into the soil as organic matter. Microscopic animals live on some of these plant remains and help to convert them into soil material.

Topography

The shape of the landscape influences soil formation because it affects drainage, erosion, plant cover, and moisture and air conditions within the soil. Undulations in the surface cause water to drain away from the high spots and to collect in the low spots.

Runoff is more rapid in the more steeply sloping areas, and therefore less water penetrates the soil. Because of the humid climate, vegetation covers most of the soil surface in the survey area. The vegetation slows down the runoff and permits water to percolate through the soil. The steeper the slope, however, the greater the runoff. For example, runoff is slow on Buckpeak silt loam, 8 to 30 percent slopes, but it is rapid on Buckpeak silt loam, 65 to 90 percent slopes.

In some places water concentrates on the soil surface or is retained in the soil for much of the year. Water drains very slowly or not at all from basins and depressional areas. The large amount of moisture received in such areas encourages the growth of plants that require much water. These are areas where reeds, sedges, and mosses have accumulated to form organic soils, such as Orcas peat. Gleyed soils are in depressional and nearly level areas. An example is Stimpson soils.

Sloping soils, such as Olympic soils, are likely to be well drained and to have A and B horizons that are brown and reddish brown. Nearly level soils are not so well drained and are likely to be grayish. An example is Nuby soils. Generally, there is also more mottling in soils that have low slope gradients.

Time

The length of time required to develop a given kind of soil depends on the climate, the kinds and amounts of living organisms, the type of parent material, and the topography of the land.

In time, a profile develops that has two or more horizons. Young soils have more weakly expressed horizons than old soils. Soils in arid climates develop more slowly than those in humid climates. Steep soils develop distinct horizons more slowly than do the more nearly level soils.

Generally, the soils of the survey area that formed in residuum are on hills; for example, Olympic soils. Enough time has elapsed for the Olympic soils to show the effects of clay movement from the A horizon and a buildup of clay in the B horizon. The clay is oriented, and clay films are forming on peds and along pore walls. Because of the age of these soils, their structure is moderately well expressed, they are well drained, oxidized colors are dominant, and weathering has taken place at a depth of more than 5 feet.

Soils that formed in young alluvium on flood plains, such as the Newberg soils, are weakly developed, and their parent material shows little evidence of change. There is only a slight darkening of the A horizon and no evidence of clay movement.

The older soils in this area are more highly leached of lime and other bases. They have lower reaction, and are generally less fertile than the younger soils.

The slumping of soils on hills destroys areas of residual soils by burying, shattering, and mixing the material. New surfaces are exposed to weathering. As a result, there are local differences in the age of these soils and in the degree of their development.

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Glossary

Ablation till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvial fan. The fanlike deposit of a stream where it issues from a gorge upon a plain or of a tributary stream near or at its junction with its main stream.

Alluvial terrace. A stream terrace composed of unconsolidated alluvium (including gravel) produced either by renewed downcutting of a former flood plain or valley floor by a rejuvenated stream or by the covering of a terrace with alluvium.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Animal-unit-month (AUM). The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as

	Inches
Low	0 to 3.75
Moderate	3.75 to 7.5
High	More than 7.5

Back slope. The geomorphic component that forms the steepest inclined surface and principal element of many hillsides. Back slopes in profile are commonly steep, are linear, and may or may not include cliff segments.

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Cable yarding. A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees generally are reeled in while one end is lifted or the entire log is suspended.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles larger than 2 millimeters in diameter.

Coarse textured soil. Sand or loamy sand.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Colluvial side slope. A slope on which the processes of dislodgement and downslope transport of earth material are or have been active and have resulted in the incorporation of rock fragments into the soil matrix.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Compaction. The process by which soil loses pore space. Compacted soil has a higher bulk density as a result of an increased load or compressive stress.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are-

Loose. -Noncoherent when dry or moist; does not hold together in a mass.

Friable.-When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.-When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.-When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.-When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.-When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.-When dry, breaks into powder or individual grains under very slight pressure.

Cemented.-Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Culmination of the mean annual increment (CMAI). The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment. In this survey, the CMAI for a particular species is based on the size of the smallest usable tree.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Cut slope. The upper part of a slope after the bottom has been cut by earthmoving equipment to make a roadbed.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diameter breast height (DBH). An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.-Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.-Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained-Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.-Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below

the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.-Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.-Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.-Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature; for example, fire that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fill slope. A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil. Sandy clay, silty clay, and clay.

Firebreak. Area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of men and equipment in fire fighting. Designated roads also serve as firebreaks.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Fragile (in tables). A soil that is easily damaged by use or disturbance.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt deposited by glacial melt water. It is commonly stratified.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not dominantly flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. *A* miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hardpan. *A* hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows:

O horizon.-An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.-The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.-The mineral horizon below an *A* horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the *A* horizon; or (4) a combination of these. The combined *A* and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the *A* horizon alone is the solum.

C horizon.-The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the *A* or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.-Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an *A* or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. *A* soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Igneous rock. Rock formed by solidification from a molten or partially molten state. Major varieties include plutonic and volcanic rock. Examples are andesite, basalt, and granite.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as

contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	High
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are-*Sprinkler*.-Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Light textured soil. Sand and loamy sand.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance-few, *common,* and *many, size-fine, medium,* and *coarse;* and contrast-faint, *distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Mountain. A natural elevation of the land surface, rising more than 1,000 feet above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides and considerable bare-rock surface. A mountain can occur as a single, isolated mass or in a group forming a chain or range.

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables-hue, value, and chroma. For example, a notation of 10YR 6/4 is a color that has hue of 10YR, value of 6, and chroma of 4.

Narrow ridgetop. A sharply crested, linear elevation of the land surface. It is either independent, or it is part of a mountain or hill, such as an extended upland between valleys. Narrow ridgetops are 50 to 300 feet wide at the crest and are associated with slopes of more than 30 percent.

Natural reforestation. The process by which an area is reforested by seeds from nearby trees. The length of time necessary for natural reforestation to occur is expressed as follows:

Readily ...	seedlings are expected to become established in 2 to 5 years

Periodically ... seedlings are expected to become es tablished in 5 to 10 years
Infrequently ... seedlings are expected to become es tablished in 10 to 20 years

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Open space. A relatively undeveloped green or wooded area provided mainly within an urban area to minimize feelings of congested living.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Productive-reserve forest land. Productive public forest land not used for timber production because of statute of administrative regulation.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as-

	pH
Extremely acid	Below 4.5
Very strongly acid	**4.5** to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	13.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is

called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saprolite (soil science). Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell (in tables). The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Site curve (50-year). A set of related curves on a graph that shows the average height of dominant trees for the range of ages on soils that differ in productivity. Each level is represented by a curve. The basis of the curves is the height of dominant trees that are 50 years old or are 50 years old at breast height.

Site curve (100-year). A set of related curves on a graph that show the average height of dominant and codominant trees for a range of ages on soils that differ in productivity. Each level is represented by a curve. The basis of the curves is the height of dominant and codominant trees that are 100 years old or are 100 years old at breast height.

Site index. The average height of the tallest dominant and codominant trees in a stand at a basal age of 50 or 100 years.

Skidding. A system of moving logs using wheeled or tracked equipment to drag a log from where it was cut to a loading area. The area disturbed by skidding is called a "skid trail" or "skidding path."

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Slump. The downward slipping of a mass of rock or unconsolidated material. The rock or unconsolidated material moves as a unit or as several subsidiary units and usually has a backward rotation on an almost horizontal axis parallel to the slope from which it descends.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil depth. Classes of soil depth are:

Shallow	10 to 20 inches
Moderately deep	20 to 40 inches
Deep	40 to 60 inches
Very deep	more than 60 inches

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0

Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stocking. The degree to which an area is covered with living trees. Fully stocked or normal stands have as many trees per acre as can use the growing space available.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 6 to 15 inches (15 to 38 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless soils* are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Tolerance. The capacity of a tree to grow in the shade of other trees and in competition with them.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Tuff. A compacted deposit that is 50 percent or more volcanic ash and dust.

Unproductive forest land. Forest land that is incapable of producing commercial-quality wood because of adverse site conditions, such as infertile or poorly drained soil, adverse climatic conditions, and steepness and rockiness which preclude timber management.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow. The action of uprooting and tipping over trees by the wind.